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ABSTRACT

These readings provide basic background information on urban integrated pest management and the development of Integrated Pest Management (IPM) programs for the control of rodents, cockroaches, and head lice. IPM is a decision-making process for deciding if pest supprssion treatments are needed, when they should be initiated, where they should be applied, and what strategy and mix of tactics to use. IPM combines a variety of approaches (tools) with which to manage pests. These include human behavior changes, habitat modification, physical controls, biological control agents, and least-toxic chemical controls. Using these techniques, an IPM program maintains the size of a pest population at or below an acceptable level. In addition, the amount of toxic material put into the environment is kept as small as possible. Included in the readings are scientific discussions of IPM as well as graphic handouts that can be reproduced and distributed. A bibliography suggesting more in-depth information and instruction in urban IPM is also included. (JN)

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URBAN PEST MANAGEMENT
Selected Readings

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JMI's Urban Integrated Pest Management Program has developed numerous pest management plans for school districts, city and county agencies, state agencies, and the National Park Service.

Other JMI Program Areas are Wildland Resources, Water and Arid Land resources, and the Socio-economic Impacts of Alaskan Development.

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INTRODUCTION

Every city (and rural) resident has to deal with a variety of pests in daily life. Even people whose homes are clean and well-maintained can have weevils in the flour, roaches in the cupboards and mice in the basement. Professional exterminators may make frequent visits, but the pests can remain troublesome. Unfortunately, few people ever receive training on how to control these pests. Pesticide sprays often seem to be the only "solution." However, the use of these substances is sometimes accompanied by acute or chronic poisoning and/or by the development of pest populations that are resistant to the pesticides used.

A more complete method for controlling these pests is Integrated Pest Management (IPM). IPM is a process for deciding if pest suppression treatments are needed, when they should be initiated, where they should be applied, and what strategy and mix of tactics to use. As the name implies, IPM combines a variety of approaches (tools) with which to manage pests. These include human behavior changes, habitat modification, physical controls, biological control agents and least-toxic chemical controls. The amount of toxic material put into the environment is kept as small as possible. Using these techniques, an IPM program maintains the size of a pest population at or below an acceptable level.

IPM is a simple, common-sense approach to pest control. One does not need to be a professional to understand it or to teach it. But the IPM process does need to be taught if people are to learn how to manage household pests safely and effectively.

These readings provide basic background information on Urban Integrated Pest Management and the development of IPM programs for the control of rodents, cockroaches and head lice. They have been compiled primarily to serve as reference tools for home/health care educators, although they can also be used as a household reference. The materials include scientific discussions of IPM as well as graphic handouts that can be reproduced and distributed. The bibliography suggests more in-depth information and instruction in urban IPM.

WHY POISONS ALONE AREN'T ENOUGH!

Each environment is capable of supporting a certain maximum population of any one kind of animal. This ability (called the "carrying capacity") is largely determined by the amount of food, water and living space available to the animals. The limited amounts of these necessities keeps the population from growing beyond the environment's carrying capacity.

When a population (e.g., rodent) is poisoned, usually a certain percentage--but not all--of the individuals are killed. Some of the rodents survive due either to a physical factor (e.g., they didn't eat enough of the poison), or to a genetic factor (e.g., they carry one or more genetic traits which make them less susceptible to the poison). Because the surviving animals are few in number, they have little competition for the food, water and living space still available in the environment. In addition, rats may immigrate in from surrounding areas taking advantage of the reduced competition. This permits the population to grow rapidly until it once again reaches the environment's carrying capacity.

Repeated poisonings using the same toxic substance will be able to kill the offspring of the rodents that had escaped poisoning earlier because of a physical factor and those susceptible individuals that recently migrated into the area. Eventually, the rat population may consist primarily of rodents that are genetically resistant to the pesticide in use. These sometimes become known as "Super Rats." Any subsequent poisoning program will require a new poison--one that may be more toxic to humans as well as to rodents.

A more permanent solution to a pest problem requires first lowering the environment's carrying capacity by reducing available food, water and living space. If the carrying capacity is maintained at a lowered level, the pest population will not be able to grow as large as it was previously. A poisoning or trapping program initiated after the carrying capacity has been reduced will bring the population down more quickly. But it is the lowered carrying capacity that will keep it down.

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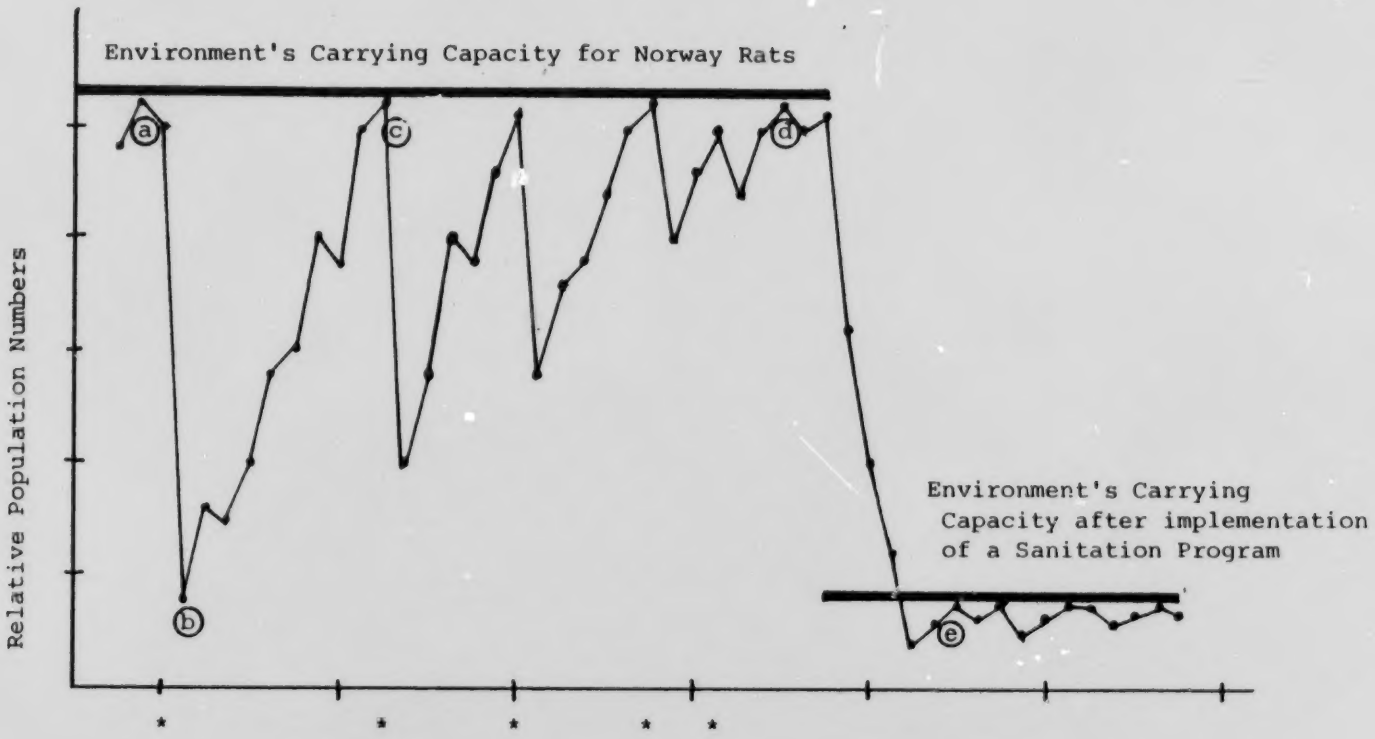
Pratt, H.D., and R.Z. Brown. 1976. Biological factors in domestic rodent control. DHEW Pub. No. (CDC)77-8144. U.S. Dept. HEW, Public Health Service, CDC, Atlanta, GA.



Pratt, H.D., and R.Z. Brown, 1976.

Point ⓐ on the graph represents the initial population of Norway rats living within the environment being monitored. This number cannot exceed the environment's carrying capacity. A poison is applied resulting in a drop in the rodent population, point ⓑ. Some individuals survive due to either a physical or a genetic factor. Since no other changes were made to the environment, these rodents reproduce until the population once again reaches the environment's carrying capacity, point ⓒ. Repeated poisonings kill proportionately fewer and fewer of the rodents. The time needed to repopulate the environment is reduced accordingly. Eventually a population of "Super Rats" is established, point ⓓ. A sanitation program is begun which reduces the environment's carrying capacity. The population drops with no further action and remains low, point ⓔ.

WHY SEEK ALTERNATIVES TO PESTICIDES?

Since 1945 pesticide use in the U.S. has increased tenfold. Nearly a billion and a half pounds of pesticides are produced each year in the United States. Over 15% and possibly as much as a quarter of all pesticide use occurs not in agriculture but in urban and suburban areas nationwide(1).

The two major reasons to reduce unnecessary pesticide use and to seek new methods of pest control are that 1) pests are rapidly developing resistance to chemical controls, see page 3 and 4) chemical controls pose risks to human and environmental health.

Types of Pesticides

Pesticides are classified by the kind of pest they are used against and by chemical group. The most common pest-based classifications include insecticides, herbicides, fungicides and rodenticides. Large amounts of nematicides, miticides, algicides, molluscicides, repellents and plant growth regulators are also used in agriculture and in urban areas.

The major chemical classes of pesticides are:

* organochlorines (also called chlorinated hydrocarbons)
* organophosphates
* carbamates
* chlorophenoxy acid herbicides

Until the 1970's, the most commonly used pesticides were in the organochlorine class. Many of the materials now banned or heavily restricted--such a DDT, chlordane, lindane, aldrin, dieldrin and toxaphene--are in this class. They are fat soluable, bioaccumulate and persist for long periods in the environment.

Replacing the organochlorines as the most popular kind of pesticide has been the organophosphate class, called the OP's. Developed in the late 1940's, this class is widely used in agriculture and in many household products. Common OP's include malathion, parathion, diazinon and dichlorvos. The OP's do not persist in the environment, are not fat soluable and do not bioaccumulate. However, they are very acutely toxic and have caused such adverse effects as birth defects and cancer in animal tests.

Carbamates were developed in part to replace organochlorines to which certain insects had developed resistance. Common carbamates include carbaryl and propoxur. Like the OP's, they act as nerve poisons and can cause birth defects.

Chlorophenoxy acid herbicides is one of the fastest growing classes of pesticide. Common weed-killers such as 2,4-D and 2,4,5-T, widely used to kill vegetation in urban, suburban and forested areas, work by causing abnormally fast growth of stems, leaves and roots.

The controversy surrounding the possible health effects of phenoxy herbicide use, centered in the northwest United States in the heart of the timber industry, is well known. In response to public protests and the exposure of multiple miscarriages in areas that had received aerial applications of 2,4,5-T, the U.S. Forest Service banned its use in federal forests. However, it can still be used on rice crops, grazing land, and at airports, lumberyards and in other industrial areas. 2,4-D has been accepted as a popular substitute for 2,4,5-T and is widely available in garden stores as a home weed killer.

Human Health Hazards

Acute Health Effects

Poisoning reactions can be severe and sudden (acute), less severe and longer lasting (chronic); an acute reaction may be followed by chronic symptoms. Toxic reactions to pesticides may be acute, chronic or both. Acute symptoms are those which are likely to occur within a short time after a single exposure to a pesticide. These symptoms may be minor and disappear within a short time or they may be serious, even leading to death. An acute reaction may be followed by chronic reactions. Ten years ago The World Health Organization estimated that about 500,000 people become ill each year worldwide from direct exposure to a pesticide and that about 9,200 of these cases are fatal(2). Pesticide use world wide has increased about 50% since then. In this country, the Environmental Protection Agency (EPA) estimates that each year approximately 200 people die from pesticide poisonings(3).

California, which has the most stringent pesticide use laws in the country, reports an average of 22 pesticide-related deaths and 9,000 pesticide-related illnesses each year in the Doctor's First Report of Worker Injury (DFR) for occupational incidents and/or the Pesticide Illness Report (PIR)(4). Administration of the reporting requirements is spread among the Department of Industrial Relations (enforcing the regulation), Department of Public Health (educating health professionals about the reporting requirements), and the Department of Food and Agriculture (investigating poisoning incidents). The California Department of Health, however, has estimated that as many as 95% of all pesticide illnesses fail to be reported through this system(5).

Susceptibility Variations

Some people are more susceptible than others to the harmful effects of pesticides. Small children and the elderly may be more susceptible, as well as sick people. Developing fetuses, especially during the first three months of pregnancy, are more at risk(6). Studies on rats have shown that low proten in diets can increase the toxic effects of some pesticides(7). Race and socioeconomic status have been shown to correlate with the amount of pesticide residues found in tissue samples with levels being highest among black and lower-income groups(8,9).

In addition, certain individuals are more chemically sensitive than others. One massive exposure or a long-term low-level exposure to a pesticide may sensitize a person to the point that subsequent exposures to pesticides and other chemicals in amounts that would normally be tolerable can produce severe allergic reactions and even death(10,11).

Long-Term Health Effects

Chronic symptoms are those which appear days, weeks or even years after exposure to a pesticide. They include the following:

* carcinogenic effects, or cancer
* teratogenic effects, or birth defects
* mutagenic effects, or changes in the genetic material (DNA) in the chromosomes. If the mutation occurs in a germ or reproductive cell, it could lead to a birth defect in the next generation. All carcinogens are mutagens. Most mutagens (but not all) are carcinogens.
* neurotoxic effects, or toxic effects on the nervous system such as convulsions, mental confusion, loss of sex drive, and psychiatric disorders.

Because they do not appear at the time of exposure, chronic symptoms are often not associated with pesticides. Cancer, for instance, may appear from five to forty years after exposure to a cancer-causing substance.

The role that pesticides may play in causing long-term health effects such as cancer and birth defects is still poorly understood. One Congressional investigative subcommittee, has estimated that "at least 25% of all pesticides on the market have shown cancer-causing potential."(12)

The recent discovery of toxic waste dumps has revealed that extremely hazardous materials, including pesticides, their breakdown products, and chemicals used in their formulation, are often improperly stored and disposed of. While

it is beyond our present scope to consider the extent of this threat to public health, it should be recognized that the environmental hazards of pesticides do not end with their regulation, restriction, or disposal.

Regulating the Problem

Federal

Pesticides (and other chemicals) are continuously being tested and reviewed by several Federal agencies, including the EPA. Pesticides under review by EPA undergo tests and are the subject of debates on the risks and benefits associated with their use, a process which may take years to complete.

For more information, call Paul Lapsley (703) 557-7420, or Mark Dow (703) 557-8195, at the EPA Special Review Branch. To follow the fate of pesticides, you can request that your name be placed on the list to receive updated lists of pesticides under special review. Betty Crompton at (703) 557-7436 can provide you with these lists.

Regular updates on all federal chemical (and pesticide) legislation can be found in Pesticide and Toxic Chemical News and the Chemical Regulation Reporter, both available in major libraries and in all EPA Regional libraries.

State

States often make pesticide regulations that go beyond the federal laws. California, for example, has several regulations concerning safety, record keeping, poisoning reporting, etc., that are not included in the federal law. Information about the laws and regulations in your state can be obtained from state departments of agriculture and possibly from county agricultural agents and departments of health. Keep asking until you obtain the information you need--it is your public right to know.

Footnotes

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What Is IPM?

Integrated pest management (IPM) is a decision making process for determining IF you need pest suppression treatments, WHEN you need them, WHERE you need them, and WHAT strategy and mix of tactics to use. In IPM programs, treatments are not made according to a predetermined calendar schedule, they are made only when and where monitoring has indicated that the pest will cause unacceptable economic, medical or aesthetic damage. Treatments are chosen and timed to be most effective and least disruptive to natural mortality factors. In agricultural settings, IPM programs have been developed for cotton, corn, alfalfa, soybean, citrus, walnut, apple, a few vegetables, and many other crops. Pesticide use on these crops has dropped significantly, while yield and quality have been maintained and improved. In urban settings, IPM has been used to manage insect, vertebrate, disease and weed pests in parks, gardens, on shade trees and in houses and apartments. In forest settings, where devastating cyclic outbreaks of pests like the gypsy moth, spruce budworm and the fungus causing Dutch elm disease are problems over large areas, IPM concepts have greatly facilitated increased cooperation between researchers in different disciplines and the development of new techniques for predicting and managing forest pests.

THE MEANING OF "INTEGRATED"

There are at least four ways in which IPM programs must be "integrated". The first meaning of integration is that many treatment strategies may be fitted together or integrated into a management program. (See the box,"Summary of Treatment Strategies".) For example, in greenhouses, researchers have figured out how yellow sticky board whitefly traps can be used along with beneficial insects to control other pests. Another example is in urban cockroach management programs, which integrate use of attractant traps, spot treatment with boric acid, habitat modification, and tenant education. This type of coordination of all available techniques results in optimal management programs.

Secondly, in designing IPM programs, the practitioner takes into consideration the many potential interactions between key pests, their natural enemies, other actual or potential pests, and other living and non-living factors. One of the first problems the IPM designer faces is determining the boundaries of the system to be managed. For example: when a fungus is causing damage, the IPM practitioner will consider the effect of fungicides on beneficial fungi which may be holding nematode populations in check; or when faced with management of a weed problem, the IPM practitioner will consider the effect of weeds on insect pests and natural enemies; or when advising a homeowner to modify certain structural components of the house, the practitioner will advise building out a number of pests at once -- not just the pest in question at the specific time.

A third meaning of "integration" is that IPM practitioners view pest management as one aspect of total ecosystem or whole system management. Social, economic, political and ecological factors affect pest management decision making. In agriculture, IPM practitioners have to look at all aspects of production -- they are even concerned with the effect of management practices in neighboring fields! How people feel about pest damage also has to be considered. Cosmetic damage to fruits and vegetables may not affect their quality and taste, but it will effect marketability and hence pest management. Aesthetic damage to landscape plants in the city may not endanger their growth, but it can reduce enjoyment of them. Another consideration is the Environmental Protection Agency's registration process for insuring pest control product safety and effectiveness. This process is time consuming and politically sensitive. It effects pest manager's choices concerning availability and use of products. IPM practitioners could be influential in product development and plant protection research if they made their pest management needs and desires known.

Finally, the fourth level of integration concerns the development of a coherent body of IPM theory that is trans-disciplinary (not bound to a particular discipline). IPM programs must incorporate the findings of entomologists, plant pathologists, architects, agronomists, sociologists, soil scientists, etc. Essentially, IPM is an intervention strategy that seeks to harmonize the relationship between human beings and other species regarded as pests.

COMPONENTS OF AN IPM PROGRAM

An IPM program contains the following key components:

- IDENTIFICATION of pests and natural enemies.
- A MONITORING and RECORD KEEPING system for regular sampling of pest and natural enemy populations. Monitoring is an ongoing activity throughout any IPM program.
- A determination of the economic or aesthetic INJURY LEVEL -- that size of the pest population correlated with an injury sufficient to warrant control actions. In determining injury levels, the amount of aesthetic or economic damage that can be tolerated must be correlated with the population size of pests, natural enemies, time in the season, and/or life stage of the pest or host.
- A determination of ACTION LEVELS -- the pest population size, along with other variables such as weather, from which it can be predicted that injury levels will be reached within a certain time if no treatments are undertaken.
- TREATMENTS -- selected strategies and mixes of tactics that are least disruptive to natural controls and least hazardous to human health and the environment.
- An EVALUATION SYSTEM to determine outcome of treatment actions.

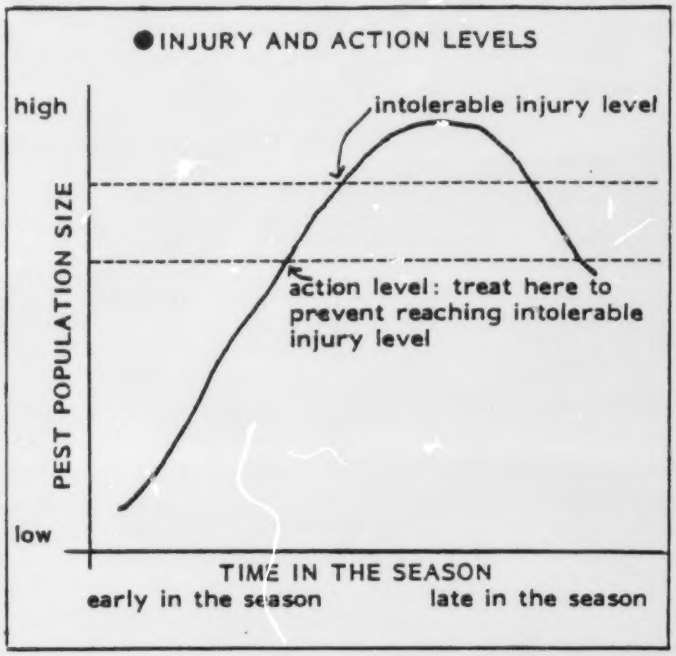
MONITORING

Monitoring means paying close attention to specific animal, plant or microbial populations, as well as human behavior and weather. Each monitoring system needs to be tailored to the particular situation. Not only must the population size of key pests and their natural enemies be recorded, but other potential pest populations, and their natural enemies may also need to be observed regularly. Cultural practices such as fertilizing, irrigating, pruning, and mulching can affect pest populations. Management of garbage and domestic animals as well as other human behaviors affecting household pests may need to be monitored. Heat, humidity, and such weather phenomena as rain, wind, and flooding can influence pest population size. Any of these factors may need to be recorded; the choice will depend on the purpose for which the monitoring is undertaken.

DEVELOPING A MONITORING PROGRAM

Here are some suggestions for both the lay public and the professional consultant on how to develop a monitoring and record keeping system:

1) Determine the PURPOSE of the monitoring. For example, one might establish a monitoring program to: determine injury levels; predict population levels; time treatments; or learn something specific about the biology or ecology of the pest or its natural enemies.



MONITORING: WHAT IS RECORDED?

1) Pest population size and distribution.
2) Natural enemy population size and distribution.
3) Presence of potential pest populations.
4) Presence of natural enemies of the potential pests.
5) Cultural maintenance activities and other human behaviors that interface with pest management.
6) Weather.

SUMMARY OF TREATMENT STRATEGIES

1) Selection of plants that are resistant to pests, and supportive of predators and parasitoids.
2) Habitat modification for purposes of: reduction of pest harborage, food or other requirements; enhancement of the environment required by the pest's predators, parasitoids and diseases; and redesign of the system so that pest problems are prevented.
3) Human behavior changes including: encouraging people to re-evaluate conventional management practices; modification of cultural and resource management practices such as irrigating, fertilizing, pruning, mulching, cultivating, and waste management; and modification of aesthetic judgements regarding cosmetic damage to food, manicuring of landscapes, and mere visual presence of certain animal species such as insects.
4) Physical controls such as: manual picking and weeding; barriers; traps; and mechanical action.
5) Biological control, including; conservation of the pest's natural enemies through proper selection, timing and placing of toxic materials and through habitat modification; augmentation through the introduction of additional numbers of the pest's natural enemies or pathogens; inoculation by the repeated reintroduction of effective natural enemies that cannot become established on their own; and importation of host-specific natural enemies of exotic pests.
6) Chemical controls including: pheromones and other attractants to lure and/or confuse the pest; juvenile hormones that arrest pest development; sterilants or contraceptives to reduce breeding of future generations; and contact stomach, and other poisons.

2) Determine WHICH POPULATIONS are to be sampled. For example, although there are many predators and parasites which could be monitored with respect to the management of most pests, some are more important to sample than others.

3) Decide on the FREQUENCY of the visits. While once-a-week observation is a common choice, this may need to be varied to suit the season, the weather, or the size of the pest population.

4) Decide WHICH SITES should be inspected. High priority areas, or those offering examples of characteristic variation in the system may be visited most frequently.

5) Determine the NUMBER of plants or locations to be sampled at each site.

6) Decide upon a PRECISE SAMPLING PROCEDURE. More than one technique or sample size may have to be tried to determine this. Pheromones, light traps, counts of organisms, and records of damage are some of the methods available for sampling.

7) Devise a RECORD KEEPING SYSTEM that is easy to use in the field.

8) Develop a system of DISPLAYING the field data for ease in decision making.

9) EVALUATE the sampling and decision-making system. For example, one might ask if the treatment actions taken had the desired effect upon the pest population without triggering other problems such as secondary pests or having undesirable effects upon the environment.

10) MAKE CORRECTIONS in the overall process.

PEST SUPPRESSION OBJECTIVES AND TACTICS

In an IPM program, the object of treatment is to suppress pest populations below their injury level, not to attempt to eradicate them. Generally, it is considered desirable to allow the pest to survive at some low level in order to maintain the presence of its natural enemies. In selecting treatment tactics, choose those that are:

- Least disruptive to naturally occurring controls upon target pest populations and other potential pest populations. ("When you kill off the natural enemies of the pests, you inherit their work." -- Carl Huffaker, director, University of California Center for Biological Control)
- Most in harmony with both short-and-long-term human and environmental health.
- Most likely to be relatively permanent.
- Easiest to carry out effectively.
- Most conserving of nonrenewable fuels.
- Most cost-effective in the short- and long-term.

("Use of a pesticide is no substitute for prevention." --Mike Dover, IPM Unit, Environmental Protection Agency.

Finally, it is important to remember that in large measure, pest problems have been designed into our human managed systems. The most energy and cost-effective pest management strategy is to design the pests out of the system. Through the selection and mix of plant species, the design or remodeling of structures or landscapes, the contouring of sites, and the design of organic waste and other resource management processes, the extent to which we provide the preferred harborage, food, water and other requirements of the life cycle of the pest can be reduced.

This reading is available in a pamphlet form from the Bio Integral Resource Center, a nonprofit corporation undertaking research and education in ecosystem management. The original article upon which the pamphlet is based was written by Helga Olkowski and appeared in The IPM Practitioner 2(5), May 1980. Copies of the pamphlet are available from BIRC, 28A, Rt. 2, Winters, CA 95694, 916-795-2322, at a cost of $.25 per pamphlet plus $1.00 for handling in quantities up to 100. Bulk prices are available.

SELECTED ANNOTATED BIBLIOGRAPHY: AN INTRODUCTION TO IPM

The following introductory books are recommended by The IPM Practitioner. They are listed in chronological order to demonstrate the growth and elaboration of the IPM paradigm.

• = good introduction for the lay person
+ = recommended for beginning students

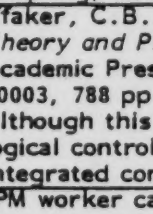
Stern, V.M., R.F. Smith, R. van den Bosch and K.S. Hagen. 1959. The Integrated Control Concept, *Hilgardia* 29(2):81-101.
This earliest paper to mention the phrase "integrated control" still makes good reading today. Integrated control theory was the precursor to IPM.

Kilgore, W.W. and R.L. Doutt (eds.). 1967. *Pest Control, Biological, Physical, and Selected Chemical Methods.* Academic Press, 111 5th Ave, New York, NY 10003, 477 pp, $58.50.
This volume discusses the different strategies (e.g. biological, microbial, electromagnetic, radiation induced sterilization, chemosterilants, pheromones, repellants, antifeedants, and behavioral manipulation) for IPM and includes an excellent chapter on Integrated Control.

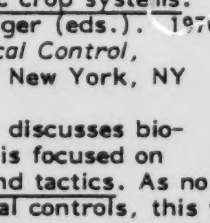
National Academy of Sciences. 1969. *Insect Pest Management and Control.* N.A.S., 2101 Constitution Ave., Washington, D.C. 20418, 508 pp, $12.75.
A comprehensive text on insect pest management with examples of such strategies as identification, plant and animal resistance, and regulatory, biological, microbial, genetic, cultural, physical and chemical controls. Integrated systems and economic principles of pest management are also discussed. The third of six volumes on pest control. References are only listed after the sections.

Metcalf, R.L. and W. Luckmann (eds.). 1975. *Introduction to Insect Pest Management.* Wiley-Interscience, 605 3rd Ave., New York, NY 10016, 587 pp, $32.00.
This book is divided into sections on principles, tactics, strategies, examples (cotton, forage, tree fruit, forest, man and domestic animals) and an epilogue in which future directions are discussed. Good for understanding ecological theory, sampling, modeling and specific crop systems.

Huffaker, C.B. and P.S. Messenger (eds.). 1976. *Theory and Practice of Biological Control,* Academic Press, 111 5th Ave., New York, NY 10003, 788 pp, $60.50.
Although this volume primarily discusses biological control, about 1/3 of it is focused on integrated control strategies and tactics. As no IPM worker can ignore biological controls, this volume is important because it shows how IPM and biological control are intimately related.



black scale parasite
Scutellista cyanea



syrphid fly
Eristalis tenax

• Goldstein, J. and R.A. Goldstein. 1978. *The Least is Best Pesticide Strategy, A Guide to Putting Integrated Pest Management Into Action.* The JG Press, Box 351, Emmaus, PA 18049, $8.95 (paperback).
Written for consumers, farmers, students and policy makers to signal why IPM is beneficial. Includes listings of college programs, consultants and sources of beneficial insects. Reviews research and economic results. Discusses the organic movement.

Bottrell, D.R. 1979. *Integrated Pest Management.* Council of Environmental Quality, U.S. Government Printing Office, Washington, D.C. 20402, 120 pp, $4.75.
This report is broad in scope and depth, covering the federal role and government policy. It includes agriculture, forestry, rights-of-way, medical and wildlife pests. It was written as a result of a presidential directive that the Council review pest management programs and recommend federal action to encourage IPM.

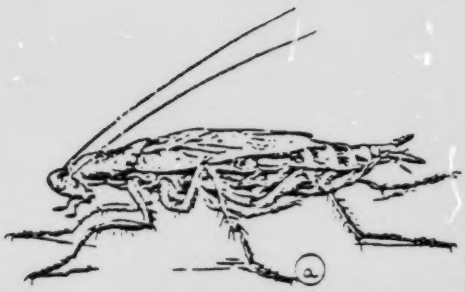
Knipling, E.F. 1979. *Basic Principles of Insect Population Suppression and Management, Ag. Handbook 512;* U.S. Government Printing Office, Washington, D.C. 20402, 623 pp, $11.00.
A comprehensive, theoretical text that bridges population ecology and pest management.

+ Flint, M.L. and R. van den Bosch. 1981. *Introduction to Integrated Pest Management.* Plenum Press, 233 Spring St., New York, NY 10013, 240 pp, $18.95.
This is a good comprehensive text for beginning students. It starts by covering basic ecological principles, the early history of pest control, the economic, social and environmental costs of pest control, and the philosophy of IPM. It then moves to practical procedures like monitoring and decision making and a discussion of case histories, and the role of the IPM specialist. Finally, there is a chapter on future possibilities.

Pimentel, D. (ed.), 1981. *Handbook of Pest Management in Agriculture.* CRC Press, 2000 N.W. 24th St., Boca Raton, FL 33431. Three volumes: Vol. 1 - $69.95; II - $67.95; III - $69.95.
It is unfortunate that these technical, comprehensive volumes are so expensive. They present a great deal of information about the crop ecosystem, the side effects of pesticides, the developing science of IPM, and many specific case histories.

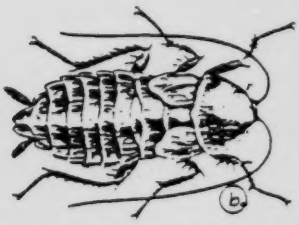
Contract Specifications: The Weak Link in the Transition to Cockroach IPM

by William and Helga Olkowski, Kathleen Cowles, Kevin Hackett and Al Giraldi



Four cockroach management programs, recently undertaken in three schools and a large office building, show that one of the major obstacles to adopting the IPM approach is the contract between the institution and the pest control company. In addition, these cases have shown: 1) that roaches can often be suppressed below injury levels with habitat and waste management techniques, trapping, and with minimal use of boric acid; 2) pest control companies do not regularly supply their clients with data for the client to use in judging program effectiveness; nor do they usually provide educational materials describing the role that clients can play in encouraging or suppressing roach populations.

Description of Studied Cases



Personnel of the center for the Integration of the Applied Sciences (a division of the John Muir Institute, Inc.), working in three U.S. cities with funds provided by the Charles Stewart Mott Foundation and the Environmental Protection Agency, are studying how to implement demonstration IPM cockroach projects. Two elementary schools were selected in Washington, D.C. (Key and Amidon), while one was chosen in Flint, Michigan (Cook), for initial demonstrations. The Washington school district manages its own pest control, while the Flint school district hires outside services. An office building used for study of IPM cockroach implementation, the Parklawn Building in Beltsville, Maryland, houses the headquarters of the Public Health Service, the Center for Disease Control, the Food and Drug Administration and the Secretary of the Human Health Services Agency. About 8,000 employees work in this building on 18 floors and three wings. The building has a large cafeteria and four small food stores. It is owned privately but is leased by the General Services Administration to other federal and various private companies. The General Services Administration hires a maintenance company for the building, and this firm hires a pest control company. A different pest control company is hired by the cafeteria management.

Program Elements

The program, designed for implementing IPM in the study locations described above, included the following elements: 1) education of building management, pest management personnel, and employees / tenants / students; 2) monitoring, using commercially available roach traps; 3) establishing a record keeping system; 4) habitat modification (at Cook); 5) alteration in waste management practices; 6) selective use of boric acid (at Cook).

The educational component involved periodic meetings with pest control companies, management personnel, custodians, principals, teachers, students and employee groups. The objective of this work was to describe what is known about cockroach IPM and to reach agreements on the next steps in implementing the program. The modes of interaction included lectures, group meetings, and contact in person or by phone for discussion of program objectives and procedures. Educational materials and papers were distributed which described the overall program. Memos summarizing discussions and agreements achieved in meetings were also used.

The monitoring component involved placing traps in appropriate locations and returning at regular intervals to read trap captures, replace traps, and compile records of roach numbers. Trapping was started in all cases while routine insecticide treatments continued. After a trapping period of at least one month, during which one or more normal insecticide treatments, and two or more trap readings were made, the routine insecticide treatments were halted. Thereafter, it was agreed that pesticide treatments would occur only where trap catches were excessive. The actual trapped numbers considered excessive were not specified initially. The original project design stated that after the initial trapping program was established, it would be taken over by existing maintenance personnel, or a local pest control firm.

The record keeping component included records of trap locations and catches, all insecticide treatments (trade name, formulations, active ingredients, time, place, personnel making the applications, and any difficulties encountered), and all visits and other relevant observations. The results of treatments and trap catches should regularly be transmitted to pest management personnel. Records were also kept of habitat modifications and changes in maintenance practices. These records were correlated with changes in roach populations and helped in evaluating treatments.

The IPM Practitioner, Dec., 1981, Rte. 1, Box 28A, Winters, CA 95694

This column, developed by the staff of the Center for the Integration of the Applied Sciences, a division of the John Muir Institute, under a cooperative agreement with the U.S. Environmental Protection Agency, is a regular feature of *The IPM Practitioner*. Information contained in this column was not reviewed in advance by the EPA, and the authors are solely responsible for its content.

The habitat modification component sought to eliminate roach habitats (cracks in walls, around pipes, behind and within cabinets, in furniture, etc.), and to deny food and water to roaches by sealing food storage containers, fixing water leaks and screening air vents and water drains. This approach requires the use of caulk, caulking guns, paint, putty, patching compounds, and weather stripping screens. Habitat modifications were scheduled sequentially, beginning after base line data was collected, and shortly after cessation of normal insecticide treatments. It was concentrated where trap catches were highest.

The waste management component was concerned with discovering the connections between pest populations and wastes. For example, roaches feed on waste food scraps and grease collected on kitchen walls, equipment, drains, floors, and in waste receptacles. Changes in maintenance practices can reduce food sources.

The selective chemical component involved the use of boric acid in certain areas to augment habitat modification and waste management procedures. Such areas include wall voids, under kitchen equipment, behind cabinets, under stoves, near motors, etc. (Areas regularly exposed to moisture should not be treated with boric acid, as moisture may render it ineffective. Care also needs to be taken to prevent food contamination.)

Findings

In all cases, before initiation of the program, organophosphate insecticides had been applied regularly on a calendar basis. Initial trapping results revealed many areas which received routine treatments but where no roaches were trapped. In other areas, very few roaches were trapped (less than five over a two week period). Only a portion of the total areas showed larger numbers trapped (20-50 over a two week period). As a result of these findings, routine insecticide applications were eliminated without increases of roach populations and with no other program modifications except trapping and spot treatments with boric acid in areas with the highest catches.

During collection of base line data, while routine insecticide treatments continued, large roach populations were present in certain areas. When insecticide treatments were suspended, and habitat and waste management were instituted, the same roach populations were observed to drop (Figure 1). Clearly, the IPM program was more effective than routine insecticide use. However, even in the face of this evidence, adoption of the demonstrated procedures has not taken place where contracts exist with outside firms in the Parklawn Building and in the Flint school system. In the Parklawn Building, both the pest control company and building maintenance personnel expressed interest in the IPM program, and approval of its techniques and results (particularly reduced occupational exposure to pesticides). However, it was made plain that no changes could occur as long as the contract specified routine pesticide treatments and did not require other IPM program components. The one school system that has agreed to adopt IPM techniques is the one in Washington, D.C. where the district has its own internal pest control unit. Apparently, this will allow them to shift to new procedures without having to obtain new contract specifications.

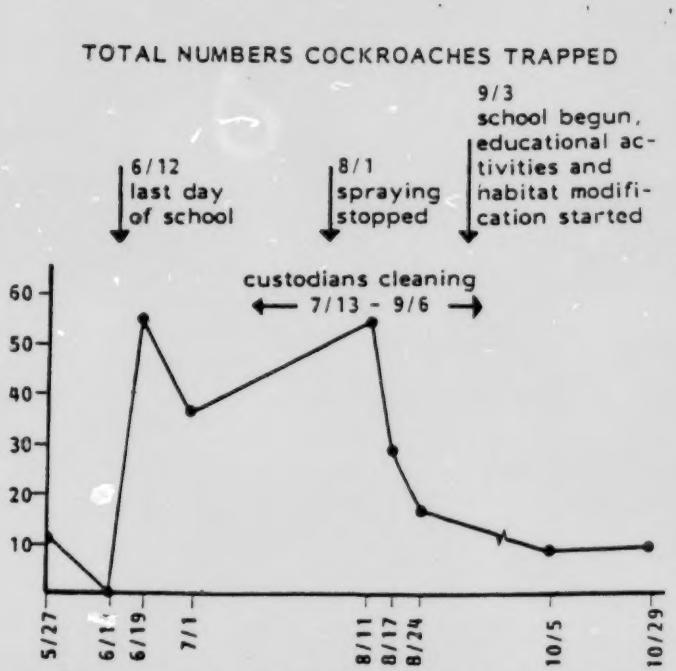
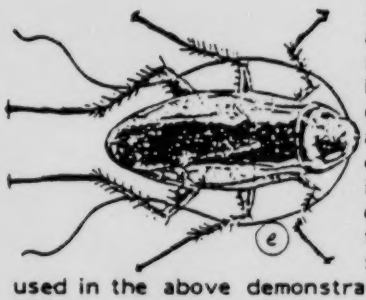


Figure 1: Roach trapping results, Cook elementary school, Flint, Michigan, summer, 1981. 32 trap locations. (Similar patterns were observed in all sites monitored.)

Conclusions



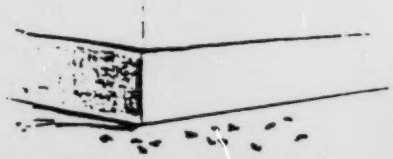
If this study is indicative of the situation nation-wide, and we believe it is, then in order to encourage the adoption of IPM procedures, contract specifications need to change. We suggest that new contracts specify the components used in the above demonstration projects: 1) monitoring, using roach traps in an initial survey to indicate areas which subsequently will be treated; 2) continued trapping at three month intervals to evaluate sizes and distribution of roach populations; 3) delivery of copies of records from trapping efforts; 4) a proposed plan submitted to the client for habitat modification and selective chemical treatments; 5) delivery to the client of records of chemical and other treatments at the conclusion of each visit; 6) a plan for delivery of educational services, developed with and approved by the contracting officer. Until these or similar specifications are built into pest control contracts, and tested for workability, IPM developments for cockroaches will be delayed.

Illustrations: a) Blatta orientalis, the oriental cockroach, male, b) female B.o.; c) Phyllodromia germanica, the German cockroach, female; d) male P.g.; e) Periplaneta americana, the American cockroach.

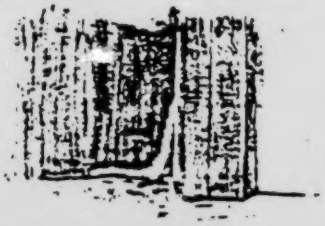
Integrated Pest Management for RODENTS

How to tell if you have rodents without seeing them.

Look for:



Droppings...tracks...trails



evidence of gnawings

damaged food containers

rub marks or discolorations

burrows.

Pitter-patter inside probably comes from mini-paws...

Kathleen Letcher Cowles is the Flint project coordinator for the John Muir Institute of California. Cowles is working with Flint residents to teach organic means of pest control.

Does your house have the pitter-patter of little feet ... even when your family is asleep? Chances are that a family of mice is sharing your warm home as the weather outside gets nippy.

Mice can be controlled by a program that includes sealing holes that let them into your house, removing their sources of food and living places inside the house, and then removing the resident mice through the use of traps.

Mice are incredibly flexible creatures that can squeeze through a crack the size of a dime. And new ones will keep entering your home as long as mice have legs and your house has heat.

YOUR FIRST STEP in getting rid mice is to rid of the holes that open your home to the outdoors. Replace or patch broken siding and fill foundation cracks with patching cement.

Use weatherstripping around cracks in doors and replace worn thresholds. Keep the heat in and the mice out. (Remember: A ¼-inch crack under the door loses as much heat as a 9-inch diameter hole hole in your wall.)

Mice aren't picky. They'll gladly eat your stored food, your garbage, and and your pet's dinner. You can limit their meals by

THE FEAT BEAT

separating organic (food) waste from other trash and storing it in a tightly covered garbage can, storing dried food in lidded containers or in the refrigerator, removing pet food after the animal has eaten and generally keeping your counters and sink food-free.

Mice often make their nests inside your home in discarded newspaper, clothing, appliances or furniture. Bundle and recycle old newspapers (call the FEAT Foundation at 239-0341 for details).

FLINT GOODWILL industries provides free home pickup of furniture and appliances in the greater Flint area (call 762-9960) and the Salvation Army will pick up reusable furniture and appliances (234-2678). Flint's Department of Public Works will pick up furniture and appliances if an appointment is made in advance (766-7076).

Get rid of mouse homes in your yard, too. Raise wood piles at least 12 inches from the ground and keep them well away from your back door. Clean out your garage to prevent mice from breeding there during the winter — and migrating inside.

Mousetraps remove the problems of poison bait exposure (for humans) and poison bait resistance (for mice) —and remove your mice as well.

The traditional snap-trap is effective, although the new "Trapper" mousetrap (available at Taber's Marathon Detroit Street and occasionally at Meijer's) allows you to remove the mouse without touching it.

MOST VETERAN trappers prefer to use a small amount of peanut butter with a bit of oatmeal as bait.

Because mice usually run right next to the wall, a trap set at right angles to the wall will catch mice travelling in either direction.

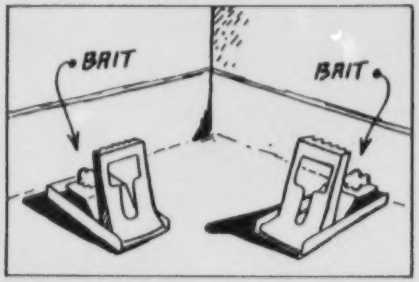
Set five to 10 traps, one to two feet apart in areas where a mouse has been spotted. Remove the traps after several nights and reset them a week later. Continue until the mice are gone.

23

24

TRAPPING TIPS

WHERE TO TRAP



- Put most of the traps near their nests and holes (5-10 traps per hole).
- Set traps 1 ft.-2 ft. apart.
- Place traps at right angles to the wall so that mice running along the wall from either direction will be trapped.

WHEN TO TRAP

- Leave traps set for 2 days and nights and then remove them. (Mice get trap shy if traps are left for too long.)
- Reset traps 1-2 weeks later (in slightly different locations).

BAITS THAT WORK

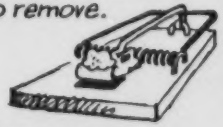
FAVORITES: Peanut butter
Oatmeal
Gumdrops

NOT-SO-FAVORITE: Cheese

- Adjust trap sensitivity so that a slight touch sets it off.
- Trap the mice - don't feed them! Use just a little bit of bait.

TYPES OF TRAPS

TRADITIONAL "SNAP" TRAP
- effective and inexpensive.
- can be messy to remove.



"METAL LEVER" TRAP
- easy to use (no need to touch mouse).
- effective but more expensive than the snap trap.

GLUE BOARD
- mouse sticks to board and dies (can take up to 24 hours).

NEW TRAPS ARE BEING DEVELOPED ALL THE TIME. CHECK YOUR LOCAL STORES.

THE PROBLEMS WITH POISONS

- Potentially hazardous to human beings, pets, and other "non-pests".
- Mice often die in inaccessible areas after eating the poison - leading to odors and flies.
- Some mice are naturally resistant to poison (i.e. they can eat it without being harmed). If their food, hiding places, and access to your home are not removed, they will multiply rapidly - with many resistant offspring!

TO GET RID OF MICE, GET RID OF THEIR:

- **ACCESS**
- **FOOD**
- **HIDING PLACES**

TEXT: KATHLEEN LETCHER COWLES
ILLUSTRATION: LEE MARRS
PRODUCED BY: CIAS, A DIVISION OF JMI INC., UNDER A GRANT FROM THE C.S. MOTT FOUNDATION

FOR FURTHER INFORMATION, CONTACT:

MICE

YOU CAN GET RID OF THEM!

HOW TO GET RID OF MICE

KNOW YOUR FOE!

HOUSE MOUSE

7 inches

NORWAY RAT

12 inches

MICE AREN'T NICE!
They carry diseases, destroy property, spoil food, and cause fires by chewing on electrical wires.

MICE NEED:

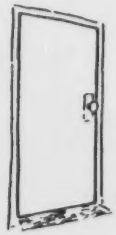
- **ACCESS**

- **FOOD**

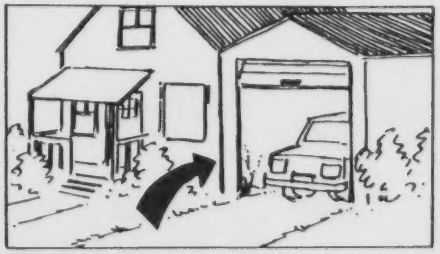
- **HIDING PLACES**

1. BUILD THEM OUT OF YOUR HOUSE

Patch holes in the foundation. (A mouse can fit through a hole the size of a dime.)



Seal cracks around your doors. Replace worn thresholds.



Seal holes between the house and the garage.

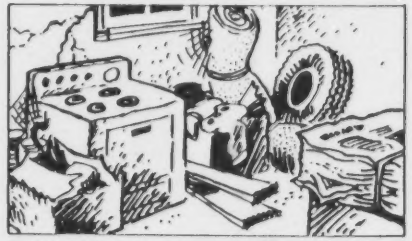
2. TAKE AWAY THEIR FOOD

Use containers with tight-fitting lids to store your flour, crackers, sugar, and cereal, or — keep it all in the refrigerator.

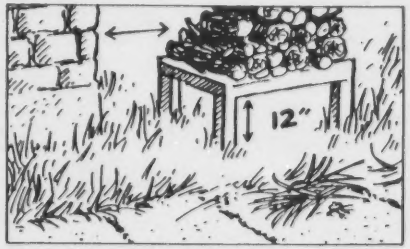
OUTDOORS: Put garbage in metal containers with tight covers or lid fasteners.

INDOORS: keep garbage in plastic containers with tight lids.

3. TAKE AWAY THEIR HIDING PLACES



Discard or recycle all unused clutter: appliances, clothing, furniture, newspapers, and all trash (from the garage too!)



Raise woodpiles at least 12 inches from ground. Cut all tall grass and weeds. Dispose of clippings and other rubbish.

4. TRAP MICE ALREADY IN YOUR HOME

(See other side for details) →

URBAN ECOSYSTEM MANAGEMENT: IPM FOR THE HOUSE MOUSE

If a man can...make a better mouse-trap... the world will make a beaten path to his door.
--Emerson

Introduction

An IPM program for the house mouse, *Mus musculus* Linneaus, has the same basic components as the program for rats, i.e., monitoring, education, habitat modification and population suppression (Olkowski and Olkowski, 1980.) However, the emphasis within the program is slightly different. The propensity to think of the house mouse as a small version of the rat is common, as they are closely related, but this neglects important characteristics of the mouse which can help to focus attention properly on particular management elements.

Probably more is known about the biology and physiology of *M. musculus* than any other mammalian species because it is the most widely used laboratory animal. Thus the literature concerning this species is immense. However, most of it concerns those strains derived from the cultures established by C.C. Little in 1909 with an emphasis on genetic, pharmacologic, cytologic, behavioral, physiological, oncological and biochemical information (Green, 1966). Few documented results exist on deliberate population reductions of mice. More information is available on feral populations but very little on urbanized commensal mice. This report reveiws what is known and draws needed attention to this species.

Origin and Importance

M. musculus is now a cosmopolitan commensal of humans, originating from the savannah and steppe country on the border of Iran (then Persia) and the USSR. Its dissemination paralleled the spread of small grain crops (Schwarz and Schwarz, 1943).

Mice damage food, clothing, documents and other human artifacts and structures by gnawing, urination and defecation. The damage to food stores from mice wastes is probably 10 times the damage attributed to direct feeding. Many fires of "unknown cause" are undoubtly due to mice (and rats) which chew through wires. Although precise and rigorous proof of the role and extent of involvement is unkown, mice have been implicated in a number of important human diseases (see Rowe, 1966, and TABLE 1). The house mouse, unlike rats, is often a pest to the rich and poor alike, and should be considered at least as important, since it probably produces more economic and nuisance damage. Curiously, mice are more socially acceptable than rats (Marsh and Howard, 1977).

Monitoring and Detection

Frequently the sight of a mouse running across the kitchen floor is the first sign of infestation, but droppings, nest material, or gnawing damage are other common indicators. In larger populations night inspections with a good flashlight can assess the extent of an infestation. In such cases a characteristic musky odor can help differentiate mice from rats. Tracks, runs and smudge marks will also provide signs of mouse presence. Urinating pillars, composed of collections of grease, urine and dirt, will indicate long-term infestations. Wet and dry rodent stains fluoresce under a black light.

The first step in assessing the pest problem is to identify correctly the invading species. TABLE 2 lists the characteristics of species which could be confused with the house mouse. FIGURE 1 pictures the notch on the upper incisor which is indicative of house mice.

The difficulty in making population assessments for house mice probably accounts for the paucity of useful documented studies. Patches of talc spread at various intervals throughout a building can provide an indirect measure of mouse presence. The percentage of patches with tracks can provide an indication of population size. These patches can be used both before and after a control operation to evaluate effectiveness.

Live trapping, marking and release techniques are generally useful only for special research purposes, so are not recommended for use in an IPM program. Direct feeding can be used, however. Place measured amounts of finely ground cereal in numerous locations throughout a building. Whole grains or chunk baits will be carried off and thus are not useful. Keep doubling the amount offered (e.g., 15, 30, 60, etc., grams) until the amount taken levels off. Then divide the amount eaten in one night by 1/20 ounce or 1.5 grams--which is the approximate amount eaten by one mouse per day. This procedure provides a rough estimate of the minimum number of mice present.

The best and most accurate censusing technique is snap trapping. Population density variations over time and among structures can be compared by calculating an index of the number of trapped mice per number of traps set per night (e.g., 40 mice/100 traps/night = 40%) (Marsh and Howard, 1977).

FIGURE 1
NOTCH IN THE UPPER INCISOR OF *Mus musculus*

Source: Berry (1970)

Biology and Population Dynamics

The reproductive rate of house mice is formidable. The females are polyestrus, having periods every 4 days. Mating takes place at the onset of estrus. Assuming an average litter size of 6.7, and a gestation period of 20 days, plus an 8-day period during suckling when estrus does not occur, one pair alone theoretically can produce 87 young per year (see TABLE 3). The average proportion of urban populations of fecund females found pregnant during the year was 22% (Laurie, 1946). Thus, various environmental factors limit the maximal reproductive powers of this species.

An indoor population is limited by available food, shelter and possible competing species. Since rats are predaceous on mice as well as competitors for the same

TABLE 1
SOME MOUSE IMPLICATED DISEASES OF HUMANS

DISEASE	CAUSAL AGENT	TRANSMISSION
salmonellosis	*Salmonellia* spp.	contaminated food
rickettsial pox	*Rickettsia akari*	by house mouse mite
lymphocytic choriomeningitis	LCM virus	contaminated food, dust on fecal particles
ratbite fever	*Spirillum minus*	by bite
tapeworms	*Hymenolepis nana* *H. diminuta*	droppings contaminated food
favus, ringworm	*Trichophyton schoenleinii*	direct contact or from mites
dermatitis	house mouse mite, *Liponyssoides sanguineus*	bites humans
bubonic plague	*Yersinia pestis*	infested flea
Neil's disease, infectious jaundice	*Leptospira ictero-haemorrhagiae*	contaminated food, water etc.

This column, developed by the staff of the Center for the Integration of the Applied Sciences, a division of the John Muir Institute, under a Cooperative Agreement with the U.S. Environmental Protection Agency (EPA), is a regular feature of *The IPM Practitioner*. Information contained in this column was not reviewed in advance by the EPA, and the authors are solely responsible for its content.

food and shelter, their removal often makes mouse populations more noticeable.

Once competitors are excluded from consideration, the major factors limiting the size of mouse populations are food and shelter. Water is not limiting, since this species can fill its water needs from the food it eats--even dry cereals. This capability and its small size make *M. musculus* particularly well adapted for humans' arid building interiors. In more northern climes the house mouse can take to outdoor areas during favorable parts of the year, reinvading buildings when conditions become severe. The house mouse also has a protective mechanism so that in response to stress (e.g., excessive heat) it can induce a torpor of dormancy which conserves its physiological reserves (Fertig and Edmonds, 1969).

ture while baiting provides no such evidence and additionally produces unpleasant odors from decaying carcasses. Simple "breakback" traps which are widely available are best--particularly if they have expanded triggers so they will snap when a mouse runs over them without an attempt to reach for food. These traps must be set at right angles to a wall. Some simple studies carried out by Elton (1942) with these traps in indoor environments indicated that they could be twice as effective if they were baited (with rolled oats sprinkled on the triggers) (see Southern, 1954).

Most trapping campaigns that fail use too few traps. At least one trap every 2-3 feet is needed. Extensive trapping efforts carried out by the Bureau of Animal Population of the British government during World War II indicate that high densities of traps for 2-3 days is the most efficient approach. However, small mice are seldom killed by these traps and thus remain to establish the infestation at a later period. Also, trapping over a long period of time "produces" mice that become trap shy. Traps should thus be used in discontinuous bursts and in large numbers (Southern, 1954).

Trapping is given priority here because resistance to the common anticoagulants is probably widespread, and also because directions to use these materials are widely available (Marsh and Howard, 1977). However, other procedures than snap trapping may be needed for particular sites where the usual techniques are not effective. Glue boards, sticky box traps or tubetraps (see *IPMP* 3:8) can also be effectively used in many locations. No data is available comparing efficacy of glue tubes or boxes with snap traps. CO_2 was successfully used to fumigate corn ricks in England during the war (Southern, 1954) and may again find use in certain situations.

TABLE 2

DISTINGUISHING *Mus musculus* FROM RELATED SPECIES

RELATED SPECIES	*HOUSE MOUSE*
deer mice or white-footed mice, *Peromyscus* spp.	lacks the distinct bicolored tail; upper body is brown or gray, lower body is white or creamy; lacks white feet
meadow mice or voles, *Microtus* spp.; fur never white underneath body	has longer tail and larger eyes and ears, is slenderer and much smaller
harvest mice, *Reithrodontomys*, grooved upper incisors	flat, notched (not grooved) upper incisors (see FIGURE 1)
small rats, *Rattus* spp.	has proportionally smaller feet and head

Management: Prevention and Suppression

Knowledge and attention to the factors limiting mice numbers, i.e., food and habitat, are the critical factors in pest mouse management. Preventive maintenance therefore is the best and cheapest procedure. Once a pest problem is present, however, the life-supporting habitat for the mice needs to be reduced in conjunction with removal of the mice themselves. Both removal and habitat modification are needed for effective control. Either alone will not be satisfactory for long.

The small size of mice makes mouse-proofing difficult. A fully-grown adult can squeeze through openings the size of a dime. Consequently, holes this small and larger need to be found, stuffed with steel wool, covered with sheet metal, and/or filled with caulk, plaster or similar materials. Storage of foods, particularly grains, in tight-fitting metal or glass containers will help reduce mice access. Perpendicular barriers of galvanized metal 18-24" high successfully excluded mice from grain piles during the great Australian mouse plagues (Winterbottom, 1922). This observation indicates that barriers and mouse-proofing can be effective even in preventing access to the highly-prized grains during outbreaks.

Suppression

Of the procedures available for suppression, trapping is the preferred method. Traps physically provide evidence of cap-

Biological Control

This long neglected approach deserves mention here and additional study. Davis *et al.* (1976), provides a short review article on the biological control of vertebrates. The domestic cat surely has a great impact on mice populations. Females tend to be more predaceous than males, particularly if they have been trained by "a good mouser," and especially when they have a new litter. Cats' most likely impact is to prevent or detect new colonizers rather than to suppress established ones.

Laird (1966), who also reviews the field of vertebrate biological control, reports on the successful use of *Salmonella* strains as rodenticides which are not pathogenic for humans or domestic animals. He also cites widespread use of four strains of *Typhimurium*-like salmonellas against rodents in the USSR where there is a history of the use of this approach. In recent years there, more than 350 tons of infective material has been distributed, with 65-100% field mortalities reported against various small rodent species. Elton (*op. cit.*) provides an early history of the use of microbes against rats and mice.

By William and Helga Olkowski

TABLE 3

BASIC INFORMATION ON THE BIOLOGY OF THE HOUSE MOUSE

sexual cycle	polyestrus, every 4 days, all year
size of litter	6.7; based on 9 field studies
litters/year	up to 10, based on food available
age at weaning	21 days
gestation period	19-21 days
age at mating	6-10 weeks
life span	1-2 years, maximum 6 years

From Berry, 1970; Marsh and Howard, 1977.

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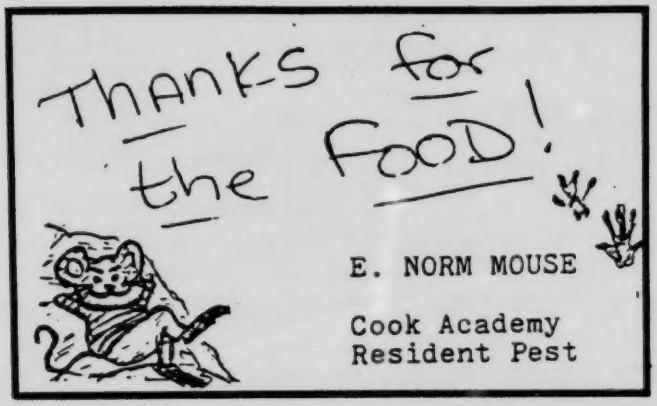
PLEASE DON'T FEED the MICE!

- They give humans diseases
(A virus can be left behind on everything they touch.)
- They chew on electrical wires and cause fires.
- They live here because YOU give them food!

NO MESS = NO MICE!

JMI 1982

"THANKS FOR THE FOOD" Business Card



As any building custodian knows, it is hard to get rid of mice while staff members are feeding them! But it is also difficult to remind adults to tidy up their food messes without causing ill will. "Pest Calling Cards" (like the one illustrated above) were distributed to the custodians at a large elementary school to make this task easier. When left at the site of a food mess, the card reminds the guilty party of the connection between messes and mice -- and does so humorously.

RAT MANAGEMENT CHECKLIST

(x) Check any of the following problems that may exist around your home.

INTERIOR

( ) Spilled or overturned food in cupboards
(To prevent spillage, items such as corn meal flour, sugar, etc,: favorites of rats--should be kept in cannisters with lids)

( ) Food left out on table or counters
(Garbage should be wrapped securely in paper, then deposited in proper container)

EXTERIOR

( ) Leftover dog or cat food in your yard
(Remove after each feeding; it attracts rats)

( ) Dog manure in yard
(Should be removed; it attracts rats)

( ) Dirty garbage and rubbish area
(Keep garbage and rubbish can area clean; rats don't need much food)

( ) Garbage cans without tight fitting lids
(All cans should have tight fitting lids to keep rats out)

( ) Trash left on your property for a long period of time (in basement, shed or garage)
(Put it in a proper container so it can be removed)

( ) Improper storage of refuse
(Plastic bags should be used only as a liner for galvanized cans; cans should be placed 18 inches off ground)

( ) Lumber lying on ground
(Stack lumber at least 18 inches above ground to keep rats away

( ) Weeds and tall grass around premises
(Cut weeds and remove brush)

( ) Abandoned cars on property
(Have them hauled away; they harbor rats)

( ) Old furniture and/or applicances on premises
(Provides excellent harborage for rats. Remove it/ them)

( ) Dilapidated shed or garage
(Should be torn down or repaired and rat-proofed)

STRUCTURE

( ) Holes or cracks around foundation (possible rat entries)
(Block entries with metal screening or galvanized metal. Repair cracks with cement)

( ) Broken basement windows
(Repair broken windows and screens)

Keep this list. If you have one or more of these conditions -- cross them off as you CORRECT them.

This Check List was prepared by Genesee County Rodent Control.

This column, developed by the staff of the Center for the Integration of the Applied Sciences, a division of the John Muir Institute, under a Cooperative Agreement with the U.S. Environmental Protection Agency (EPA), will be a regular feature of the *IPM Practitioner*. Information contained in this column was not reviewed in advance by the EPA, and the authors are solely responsible for its contents.

IPM for Rats in Urban Areas

When humans fight the rat they fight themselves.
— from Brooks and Jackson, 1973

Both common commensal[1] rat species, *Rattus rattus* and *Rattus norvegicus*, originated in Asia and have subsequently spread all over the world—primarily through transportation systems. The major differences between these species are listed in table 1. Rats damage structures; eat and urinate on human and animal foods; serve as reservoirs or vectors of plague, infectious jaundice, salmonellosis, rat-bite fever, murine typhus, rickettsialpox, and other human pathogens; cause over 15,000 rat bites per year—primarily in low-income areas; and are widespread objects of fear and revulsion. Accidental poisonings of humans and pets from efforts to reduce rat problems can be added to this list of rat-caused damage.

Finally, efforts to control rats cost a great deal of money. The Federal Rodent Control program spends about 14 million dollars annually, an amount easily matched by local and state agencies. The pest control industry grosses over 60 million dollars annually from rat control services, while about 20 million dollars is spent every year by the public, including farmers, for traps and poisons. If a basic understanding of the IPM approach to rodent control were more widely disseminated, damage and costs of control could be reduced.

Monitoring

Monitoring is necessary to find populations, assess damage, organize treatments, and develop baseline data so treatments can be later evaluated. The most common monitoring technique is counting and mapping of holes, then filling of holes, followed by recounting and mapping. This procedure establishes the initial number of active holes, which are one indicator of population size. Monitoring also includes detecting signs of rodent activities, such as pathways, passages, fecal pellets, grease marks, feeding damage, and so on.

[1]Derived from a Latin word meaning "those who share the same table," *commensal* here means "living in close association with humans." Not as close to us as ectoparasites like fleas, nor as removed as wild animals like raccoons, human commensals include sparrows, cockroaches, and mice, as well as rats. Note that rats may also be *domestic*, like cats and dogs.

Education

If monitoring is being done by a public institution or community group over a neighborhood- or community-wide area, the period during which monitoring is being conducted is also a good time for initiating educational activities about rat control. Training programs for both the general public and professional pest control personnel should focus on IPM concepts such as rat biology, monitoring techniques, injury levels, habitat modification practices, and suppressive strategies. Modification of human behaviors that encourage rodents by providing food and harborage should be stressed. Technical processes and materials for rat control have already been developed; **what is needed is an emphasis on reducing the carrying capacity of the environment through reduction of food and harborage** rather than reliance on solely suppressive strategies that fail to provide long-term control. Educational approaches and materials emphasizing integrated pest management could provide an opportunity to reestablish firmly the ecological concepts in rat control which prevailed before the introduction of effective methods of suppression.

Habitat Modification

Reducing environmental carrying capacity means reducing food, water, and harborage. In urban areas the main food sources for rats are garbage and stored foodstuffs. Improper management of garbage is a significant problem. Free-ranging dogs can exacerbate this problem by pushing garbage cans over, making the contents more accessible to rodents. Stored foods are available in residences, restaurants, food processing plants, warehouses, markets, grain mills, and port facilities. Backyard fruit and nut trees and vegetable gardens can also provide significant sources of rat food.

Harborage for rats is supplied by deteriorated structures, outbuildings, cellars, attics, wall voids, false ceilings, street drains, unused sewer laterals, debris heaps, refuse dumps, and wood piles. Ornamental plants like date palms and Algerian ivy, which in California is used as a ground cover in residential areas and along expressways, provide both harborage and food for roof rats.

Important travel routes for the often arboreal *Rattus rattus* include telephone, cable TV, and utility cables, and poles, trees, and service pipes on building exteriors and roofs. The brown rat *R. norvegicus* commonly uses sewer and drain pipes and narrow passageways between buildings and fences.

Although studies conducted 30–40 years ago showed effective long-term rodent control based primarily on habitat management, these practices were largely abandoned when emphasis was placed on the "new" anticoagulant rodenticides—warfarin in particular. Now, as anticoagulant resistance becomes widespread, and the use of these relatively safe materials comes into question, we have new impetus to promote habitat management once again.

Habitat Management Techniques

Basic habitat management involves elimination of access to food, repair of structural defects, removal of garbage and rubbish accumulations, blockage of rat passages, and hygienic storage, removal, and handling of refuse and sewage. In the home, any holes a rat can fit his skull through (roughly, ½ inch square) can provide entry. Heavy gauge (e.g., 24 ga.) galvanized metal sheeting,

Table 1— **Characteristics of Major Rat Species in North America**

	Norway rat *Rattus norvegicus*	Roof rat *Rattus rattus*
Adult body weight	1 lb.	½ lb.
Sexual maturity	3 to 5 months after birth	3 to 5 months after birth
Gestation period	22 days (average)	22 days (average)
Litter size	8–12	6–8
Number of litters per year	4–7	3–9
Number of young weaned per year	18–56	12–47
Preferred outdoor habitat	in burrows in the ground, in sewers, under foundations	in trees and dense vine growths
Preferred indoor habitat	under floors and in walls	above ground level, in attics, in walls

— from Pratt and Brown, 1976

¼ inch hardware cloth, and cement can be used to fill such holes. Cement used to seal holes or burrows in or near foundations should be mixed with broken glass to deter rats from digging the holes out again before the cement hardens. Metal sheeting showing rust spots should be cleaned and painted to prevent the metal from weakening, thus making it easier for rats to chew through. Metal cones or guards should be placed around or over wires and pipes so that rats are prevented from using them to enter buildings. Openings around pipes or conduits should be covered with sheet metal patches or filled with mortar. Basements should be paved with concrete to prevent entry. Floor drains, letter drops, and ventilation fan openings should be modified if necessary to achieve stoppage. Fit doors and wooden door jambs with sheet metal flashing. Equip heavily used doors with self-closing devices. Remove pet dishes and water after feeding. Pick up dog feces regularly. Keep areas around outside chicken feeders clean. The adhesive, Tanglefoot®, can be used as a barrier to eliminate access to bird feeders, which, surprisingly, are relatively common food sources in suburban areas.

Fig. 1. Rat guard on pole or tree

Suppressive Techniques

The reductions in carrying capacity described above are best used as preventive measures. When high numbers of rats are already present, however, suppressive techniques must be applied conjointly to prevent a migration of rats from the now unfavorable environment to neighboring areas. Suppressive techniques include traps, poison baits, tracking powders, and fumigants. Traps and glue boards are useful for small infestations and where removal of carcasses is desirable. Baiting is the most widely used technique but can inadvertantly do harm to dogs, cats, and people. Rodenticidal dusts or tracking powders are placed where rats will become exposed. Fumigation should be carried out only by trained personnel using special equipment. Many commonly used fumigants, like sodium cyanide and methyl bromide, are extremely toxic.

Baits can be divided into single- and multiple-dose groups. Single-dose materials, like zinc phosphide and the botanical red squill, can rapidly reduce rodent numbers but are more hazardous than anticoagulants, work best with prebaiting (which is time consuming), and may induce bait shyness in sub-lethally dosed animals. All multi-dose or chronic rodenticides in the U.S. are anticoagulants, which must be consumed over several days to be effective. These materials are safer than the single-dose ones (the effective antidote is vitamin K) and rarely cause bait shyness but require longer periods of baiting maintenance and may gradually select for resistant rodent populations. Any of the anticoagulant rodenticides currently on the market—warfarin, pindone, diphacinone, chlorophacinone, and coumafuryl (Fumarin)—may be excellent with respect to bait acceptance and mortality effects depending on the inert bait base material and the availability of alternate food sources.

The newly registered single-dose anticoagulant, brodifacoum, sold under the trade name Talon®, deserves scrutiny, as does any new tool. However, like any other bait, it will not be the whole answer to the problem of rats. Only an integrated program with emphasis on modification of habitats which provide food, water, and harborage for rats will insure a permanent solution.

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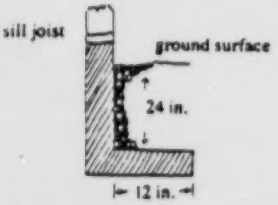


Fig. 2. Curtain concrete wall construction stops rats and mice.

Capabilities of Rats

As a Guide in Planning Preventive Measures, Assume Rats Can:

1. Pass through openings larger than ½ inch square.
2. Walk horizontal wires and (roof rat) climb vertical wires.
3. Climb inside vertical pipes 1½ to 4 inches in diameter.
4. Climb the outside of vertical pipes with diameters of up to 3 inches.
5. Climb the outside of vertical pipes and conduits of any size if within 3 inches of a wall.
6. Crawl horizontally on any type of pipe or conduit.
7. Jump vertically at least 36 inches from a flat surface.
8. Reach about 13 inches above a flat surface.
9. Swim up through the water seal (trap) of toilets.
10. Swim as far as ½ mile in open water.
11. Dive and swim under water as long as 30 seconds.
12. Gnaw on almost anything: wood, paper board, lead pipes, cinder block, asbestos, aluminum, and sun dried adobe.

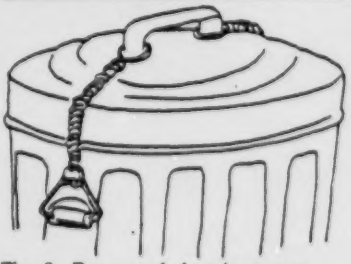


Fig. 3. Rat-proofed garbage can
spring mechanism, available in hardware stores, helps keep cover on garbage or feed cans

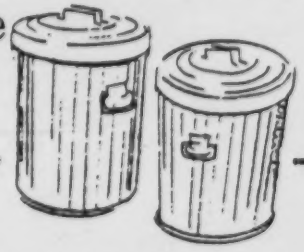
Ft. Wayne-Allen Co. Dept. of Public Health
Room 545 City-County Building
Fort Wayne, Indiana 46802

let's get rid of rats

don't give the rat a free meal

for each family

there should be containers like these



for the storage of garbage and rubbish, but certainly not containers like this . . .

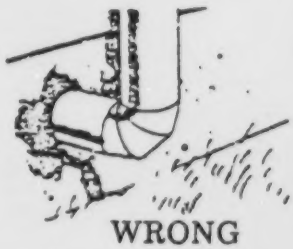
Today: Make sure you have enough metal containers with tight-fitting lids. (Metal garbage containers should not exceed 26 gallon capacity.)

garbage is rat food!

why feed him?

Bird food should be placed on raised platforms.

Make sure that all garbage, rubbish, and trash are placed in containers.

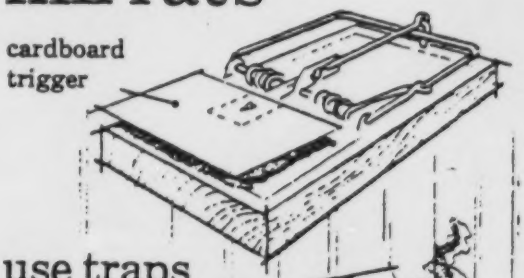


In the foundation walls all openings which are at least ½" in diameter and are within 30" of the ground should be rat-stopped with metal collars or shields or should be filled in with masonry.

why keep rats in your house or buildings

Rats inside a building are the responsibility both of the owner and of the tenant.

kill rats

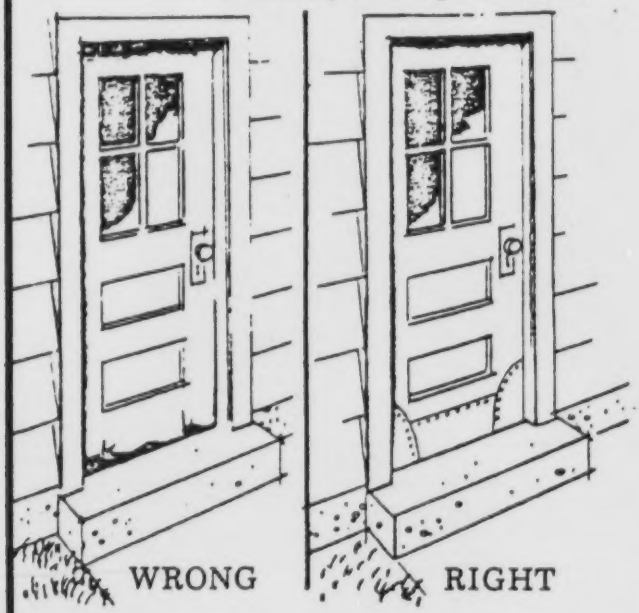


use traps

Attach a piece of cardboard to the trap to make it more effective. Set the improved trap against the wall (as shown) and make a tunnel which will lead the rat right to the trap.

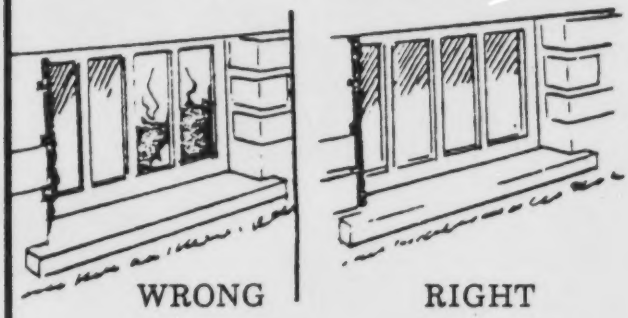
don't let rats into your home or buildings

Make any repairs which are necessary to keep rats out.



Doors should be not more than 3/8" from the frame. If they have been gnawed through or are rotted, they should be rat-proofed by the proper use of metal channels or flashing.

Basement windows should fit tightly and they should have no broken panes.



favorite breeding places of rats are:

- Piles or rubbish and ashes.
- Old boxes and lumber.
- Rags and old piles of paper.
- Discarded chairs and bedding.

you don't need junk } get rid
you don't want rats } of them

RAISE STORED MATERIALS

Place all lumber, pipes, and other stored material at least 12 inches off the ground.

clean out the cellar, attic and store-room

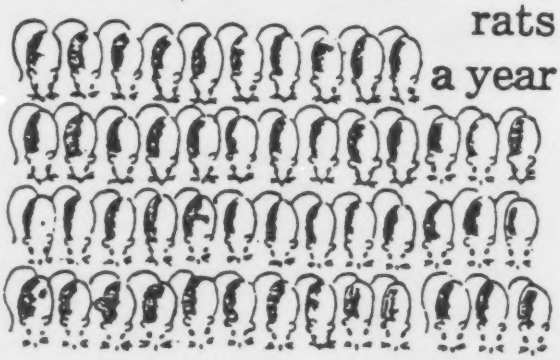
Don't give the rats a place to raise their large families.

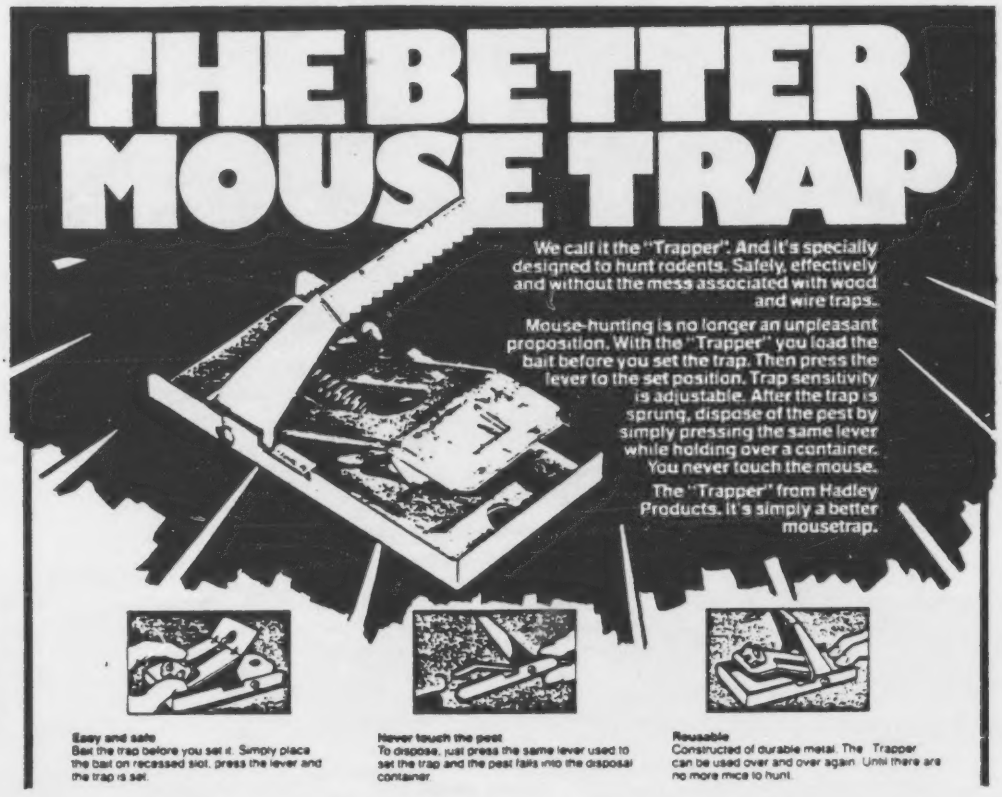
don't give the rat a place to hide

Rats live in dark, enclosed spots, such as trash piles, wood piles, double walls, wooden floors in basements, staircases, wooden sidewalks, boxed-in plumbing, closed platforms under furniture. Rip out these dead spaces, or seal them permanently.

don't give the rat a place to raise a family

one pair of rats ▶ 50 young rats a year




THE BETTER MOUSE TRAP
We call it the "Trapper". And it's specially designed to hunt rodents. Safely, effectively and without the mess associated with wood and wire traps.
Mouse-hunting is no longer an unpleasant proposition. With the "Trapper" you load the bait before you set the trap. Then press the lever to the set position. Trap sensitivity is adjustable. After the trap is sprung, dispose of the pest by simply pressing the same lever while holding over a container. You never touch the mouse.
The "Trapper" from Hadley Products. It's simply a better mousetrap.
Easy and safe
Bait the trap before you set it. Simply place the bait on recessed slot, press the lever and the trap is set.
Never touch the pest
To dispose, just press the same lever used to set the trap and the pest falls into the disposal container.
Reusable
Constructed of durable metal. The Trapper can be used over and over again. Until there are no more mice to hunt.

At Last, A Better Mousetrap!

•Trapping, exclusion by habitat modification and baiting are the main elements of an IPM program for mice. (See *IPMP* (3:9).]

Although baiting with anticoagulants is the most common control procedure currently used, it has a number of disadvantages, including: 1) production of unpleasant smells from decayed mice killed by the anticoagulant and lodged in inaccessible locations; 2) the likelihood that habitat modification will be abandoned as a management strategy because of the initial effectiveness of the bait; 3) the eventual development of a mouse population resistant to the bait; and 4) the potential for damage to the ratural enemies of mice that eat damaged or dead mice outdoors.

Ideally, baits would take a back-up role to the simultaneous use of trapping and exclusion. Of the two types of traps available, snap traps are preferred by some people over glue traps because they quickly dispatch the animal and thus are regarded as more humane. The most common snap traps are the Victor® wire snap traps, widely available nationally.

K. Cowles (623 E. 3rd St., Flint MI 48503), coordinator for an IPM program in the Flint public schools, reports that a better mousetrap has been developed. The new traps are all metal, spring-operated with expanded triggers. They are baited before setting and are easily set by pressing a lever. This makes the job of using them in large numbers convenient. Carcasses can be removed without being touched; the trap is pressed open with one hand and the mouse falls out.

Available from Hadley Products Co., Route 1, Marietta, OH 45750, 614-373-9298. Suggested retail: $2.19/card (2 traps), $80.42 prepaid/case (144 traps).

The IPM Practitioner, 3(11), Nov. 1981.

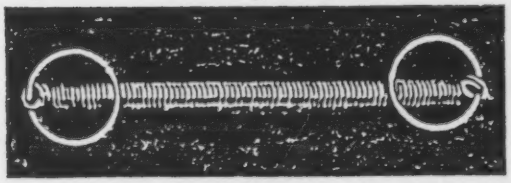
INSTRUCTIONS FOR GARBAGE CAN LID FASTENNER

Assemble one ring to each end of springs as shown in illustration #1.

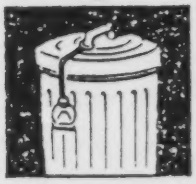
Open ring. Slip over CAN handle. Slip the other ring over LID handle, as shown in illustration #2. Do the same for the other side of the can.

Now your LID is secure, protecting the contents of the CAN from animals and spillage. Helps to prevent loss of LID, as shown in illustrations #2 and #3.

1.



2.



3.

Garbage can lid fasteners are springs which fasten to the cover and handles of a garbage can so that the cover will remain attached to the can when materials are added or removed. They are particularly useful when animals such as dogs, raccoons, or rats regularly feed from the cans. The simple device sells for about $1 in most hardware stores but if it can't be found locally, write M.E. Heuck Co., Cincinnati, OH 45223.

The IPM Practitioner, Vol. 2, No. 4, April 1981.

Integrated Pest Management for COCKROACHES

PEST COCKROACHES - A GENERAL SUMMARY

Introduction: There are 3500 to 4000 species of cockroaches with less than 1% reported as pests. The German cockroach is often considered the most important household pest in the United States. The American cockroach is second to the German in abundance in many large commercial buildings.
Cockroaches originated in tropical or semitropical Africa approximately 250 million years ago. Most species are currently found in the tropics, but pest species are usually cosmopolitan.

Physical Characteristics: Head; oval and flat, covered by a large, shield-like structure (pronotum)
Thorax; to which 2 pairs of wings and 3 pairs of legs are attached
Abdomen; usually covered by the wings
Most young and adults have an adhesive organ between their claws that allows them to climb smooth vertical surfaces.
Cockroach young (nymphs) look like adults but are wingless.

Reproduction: Eggs are laid in bean-shaped capsules called oothecae (egg case).

Development: Cockroaches thrive between 72 - 85 F, but can briefly survive temperature extremes if enough food and water is present. Their greatest reproductive potential is around 80 F, at 60-75% relative humidity.
Nymphs are white upon hatching, but they darken within a short time.
The nymphs develop in stages (instars) and moult between each stage.

Behavior: Cockroaches prefer edges, intersections and small spaces that may protect them from enemies and water loss.
They usually avoid bright lights, but may become accustomed to a calm brightly lit location.

Harborage: Cockroaches seem to prefer warm, humid, dark places with easy access to food and water.
They can flourish wherever plenty of cracks and crevices exist.

Food/Water: Cockroaches prefer starchy and sugary foods. They will readily feed upon bread, potatos, animal meals or chow. They can also eat animal feces, dead animals, plant materials, pastes, glues, leather, hair, wallpaper, fabrics and starch in bookbindings.
Feeding activity is greatest about 2 hours after dark.
Water is an important component of the diet. If deprived, cockroaches are able to obtain moisture from fruits and damp vegetables.
Can survive several weeks with no food or water.

PEST COCKROACH SPECIES - A COMPARISON

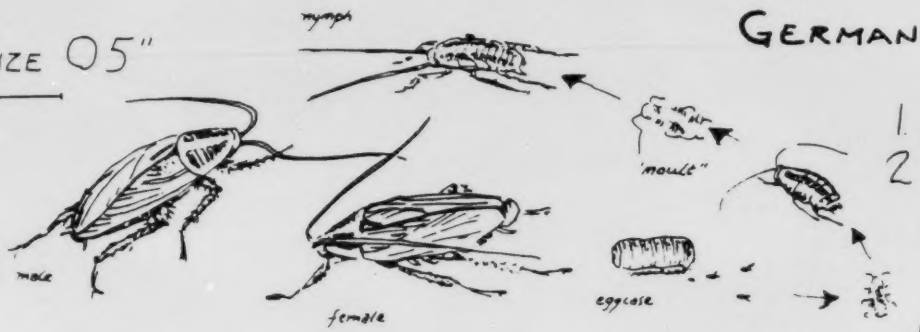
Name:	German *Blattella germanica*	Brown-banded *Supella longipalpa*	American *Periplaneta americana*	Oriental *Blatta orientalis*
Physical characteristics:	~1/2" adult lt. to med. brown full wings 2 black streaks lengthwise on back	~1/2" adult lt. to med. brown full wings 2 light bands across back	~1-1/2" adult reddish brown full wings	~1" adult dark red to brown/black reduced wings
Reproduction:	♀ carries egg capsule until nearly ready hatch Egg capsule: brownish & banded with ~18 segments; length is more than twice width 30-40 eggs/capsule 4-6 capsules/♀	♀ attaches capsules in groups on walls, furniture, etc. Egg capsule: yellow to red-brown & banded with ~8 segments; length is less than twice width 14-18 eggs/capsule 5-18 capsules/♀	♀ usually attaches egg capsule to a surface near a food source Egg capsule: laid dark brown, then turns black; no obvious segmentation but with 8-9 raised areas 18-24 eggs/capsule up to 90 capsules/♀	♀ frequently deposits egg capsule under debris in protected place Egg capsule: laid large, reddish-brown & soft, becomes black, hard & brittle; with 8-9 raised areas up to 16 eggs/capsule up to 18 capsules/♀
Development:	eggs hatch in ~1 mo. 5-7 nymphal instars ~3 mo. from egg-adult 3-4 generation/yr.	eggs hatch in ~3 mo. 6-8 nymphal instars ~6 mo. from egg-adult 2 generation/yr.	eggs hatch in ~2 mo. 7-12 nymphal instars ~1+ yr. from egg-adult 1- generation/yr.	eggs hatch in ~2-3 mo. 7-10 nymphal instars ~1-2 yr. from egg-adult 1- generation/yr.
Behavior:	flies climbs well stays in clusters does not range far if needs are provided	♂ flies, ♀ doesn't fly climbs well	flies does not range far if needs are provided	does not fly cannot climb smooth, verticle surfaces stays in clusters sluggish in movement
Preferred Harborage:	kitchens & bathrooms; may be found throughout likes moist areas	throughout dwelling, frequently in high locations likes heated areas	basements and food storage/preparation areas	damp basements & crawlspaces; can be found outdoors under debris
Food/Water:	general feeder	general feeder	general feeder	general feeder, though rarely gets into human food

-42-

GUIDE TO THE ROACH SPECIES

GERMAN COCKROACH

SIZE .5"



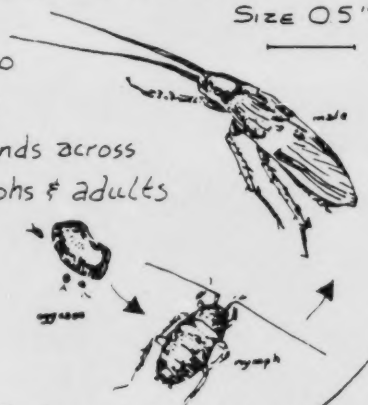
1. Light tan
2. Two black stripes along back

Preferred Habitat
Food areas, Bathrooms.

BROWN-BANDED COCKROACH

SIZE .5"

1. mahogany to tan-yellow
2. Two pale bands across back of nymphs & adults



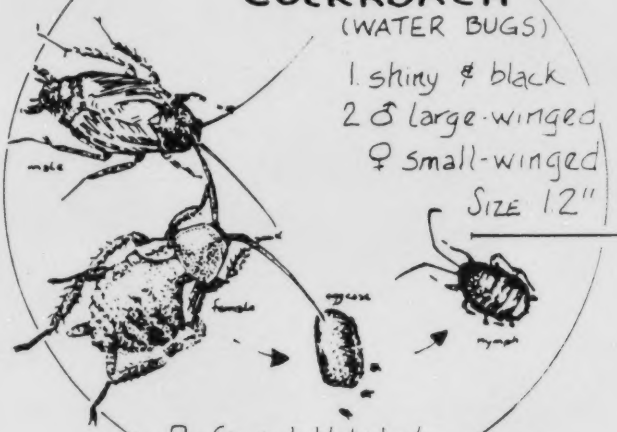
Preferred Habitat
High places, In furnishings

ORIENTAL COCKROACH

(WATER BUGS)

1. shiny & black
2. ♂ large-winged
   ♀ small-winged

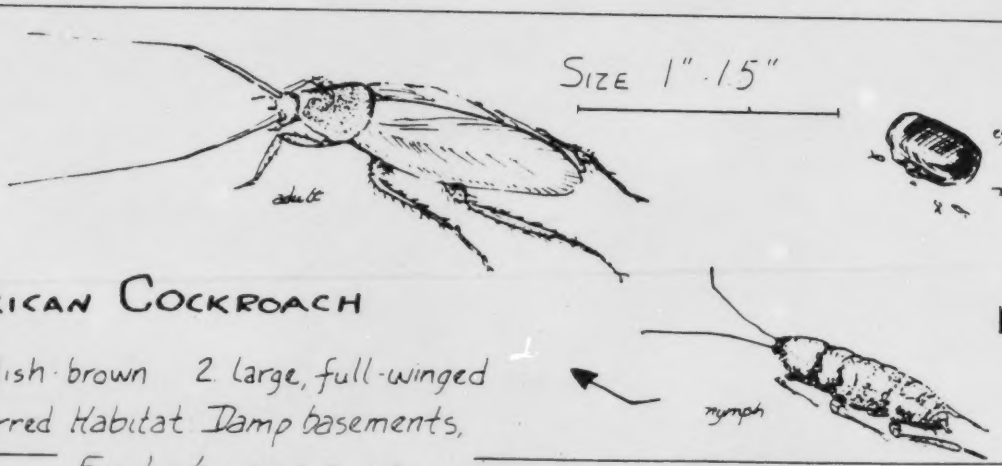
SIZE 1.2"



Preferred Habitat
Damp basements, Floors

AMERICAN COCKROACH

SIZE 1" - 1.5"

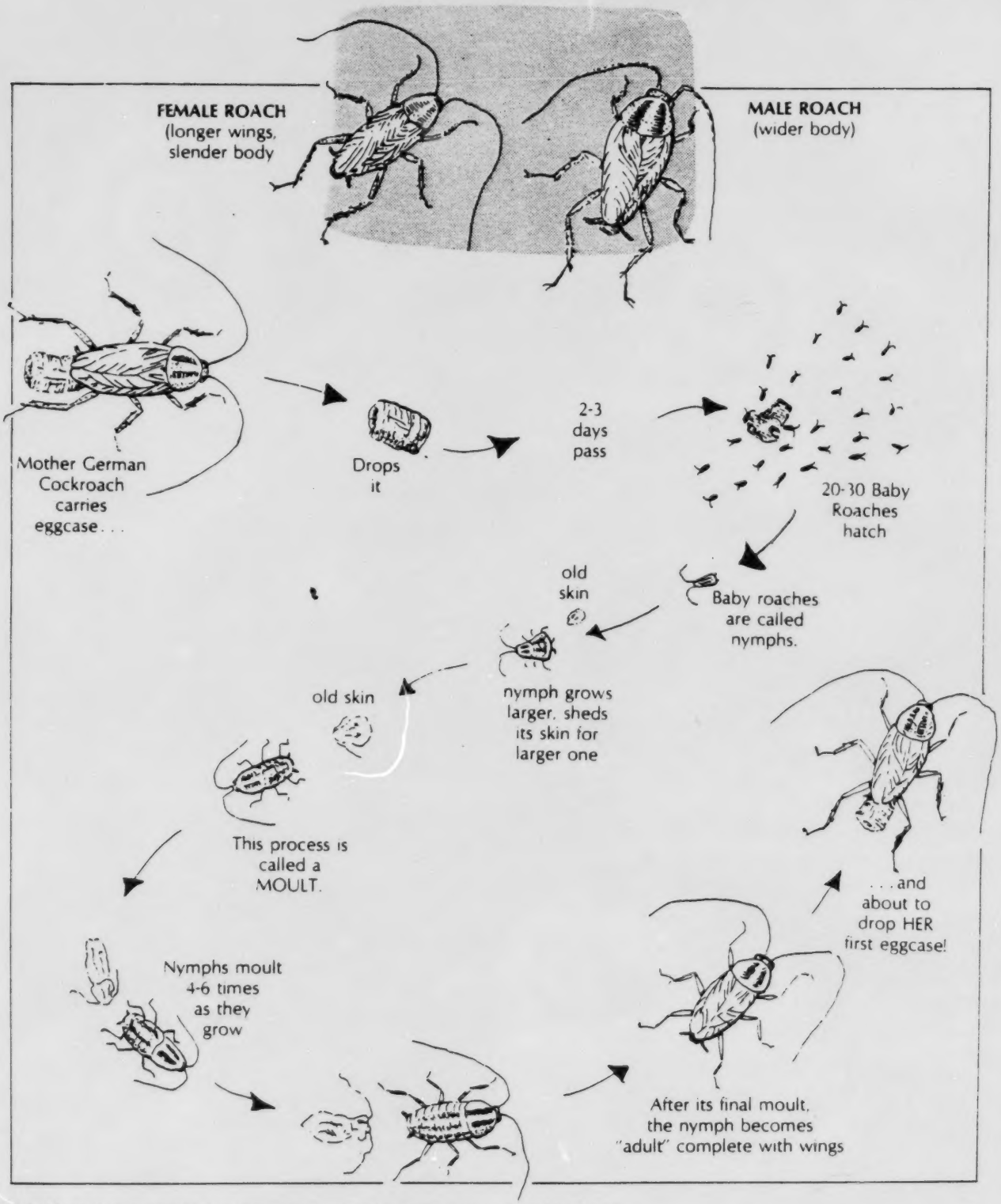


1. reddish-brown 2. large, full-winged

Preferred Habitat Damp basements,
Food storage areas.

©1983 John Muir Institute Artist Jean Prior Smith

"It's a Roach's Life"


FEMALE ROACH
(longer wings, slender body
MALE ROACH
(wider body)
Mother German Cockroach carries eggcase...
Drops it
2-3 days pass
20-30 Baby Roaches hatch
Baby roaches are called nymphs.
old skin
nymph grows larger, sheds its skin for larger one
old skin
This process is called a MOULT.
Nymphs moult 4-6 times as they grow
After its final moult, the nymph becomes "adult" complete with wings
...and about to drop HER first eggcase!

PRODUCED BY THE JOHN MUIR INSTITUTE, 743 WILSON STREET, NAPA, CA 94558 © 1983

PEST COCKROACHES - A MANAGEMENT SUMMARY

DAMAGE: Cockroaches will readily feed on man's food. They foul what they touch by disgorging portions of undigested food and taint everything with their characteristic odor.

They are suspect carriers of disease and have been implicated as carriers of food poisoning bacteria.

Humans may ingest an allergin present in the feces of German cockroaches that have contaminated food or may inhale dried fecal particles incorporated in house dust. Some apparent food allergies may actually be caused by this allergin. Some asthmatic individuals may experience relief when moving from a cockroach infested dwelling to one that is not infested.

EVALUATING INFESTATIONS: A visual sighting is the most frequent indicator of an existing infestation. Consistant sightings almost certainly indicate a problem.

In addition to the insects themselves, brown fecal smears, pellets or droppings will be present as well as egg capsules which may be hatched or unhatched, attached to surfaces or loose, usually in undisturbed locations.

MONITORING: Once it is known that cockroaches are present, traps such as Roach Motels^{R} can be used to identify the species so that management can be directed at the preferred harborage sites . (Oriental roaches are not often found in food and therefore usually do not have to be treated unless found objectionable.)

Thereafter, traps can be used to monitor the relative numbers of roaches. Traps should be placed along edges and intersections where wall meets wall, floor meets wall, cabinet meets floor, etc.

A survey should be made of food, water, hiding places and points of entry to give an indication of what relative size roach population the area is capable of supporting.

MANAGEMENT TOOLS:

Good sanitation, with the reduction of food and water sources, hiding places and points of entry, is critical in cockroach management. This must include: 1) appropriate cleaning, 2) proper storage in insect-proof containers of food and non-food stocks (animal feeds), 3) insect-proof garbage and refuse storage, 4) immediate repair of all leaks in kitchens and bathrooms, and 5) repair of breaks in walls, floors and ceilings with all cracks and crevices sealed by caulking.

All remodeling and new construction should be done so that floors, walls and ceilings are easy to clean and have no insect harborages (cracks and crevices).

Institutions should remove all clutter and items that have no use or function in food service and preparation areas as well as implement the above.

Keep dark damp basements and crawl spaces as dry and light as possible. Fewer cockroaches, specifically Oriental, will be able to survive. The cooler the indoor temperature is kept, the slower cockroach development will be.

Traps can be used to help reduce an infestation. They should be placed along intersections and corners with the broad side down.

Boric acid has been used in successful long-term control of cockroaches under some of the most adverse field conditions such as innercity apartments and restaurants. Its success is attributed to its low repellency and long residual activity. In addition, boric acid is a contact insecticide (penetrating the insects cuticle) and a stomach poison (the insects ingest large amounts when cleaning themselves). It generally takes 7-10 days before the cockroach population is noticeably reduced. Boric acid should be applied as a dust in cracks and crevices and wherever roaches congregate in large numbers. It should be reapplied wherever it is removed (accidentally or otherwise) or if it becomes wet and caked. It is relatively non-toxic to humans and other mammals, and does not give rise to vapors as do the organic insecticides. It should be kept out of the reach of small children, who may eat substantial amounts of almost any powder.

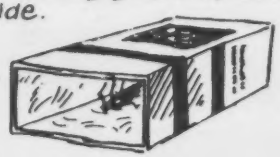
Dri-die®, a nonabrasive, highly sorptive desiccant dust, kills by causing the cockroach to dry out. It, however, is more repellent to roaches than is boric acid.

Other insecticidal agents are even more repellent and have a shorter residual life. In addition, cockroaches are easily able to develop resistance to a number of these organophosphate and carbamate based sprays.

HELPFUL TOOLS

COCKROACH TRAPS

Small cardboard boxes lined with sticky glue trap roaches inside.



Non-toxic. They can be used in kitchens.

Place next to a wall, counter, or cabinet where roaches run.

Traps are available in most supermarkets and hardware stores.

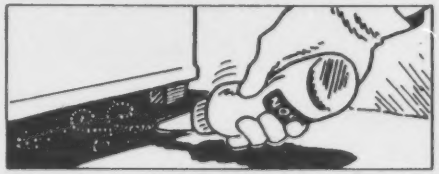
Traps tell you where the roaches are... and where you need to do more caulking, and cleaning.

BORIC ACID DUST

Doesn't mix with the air — you don't breathe it.

Put powder into a plastic squeeze bottle for easy application — label as shown.

Apply a thin, even dusting to inaccessible cracks where roaches can hide.



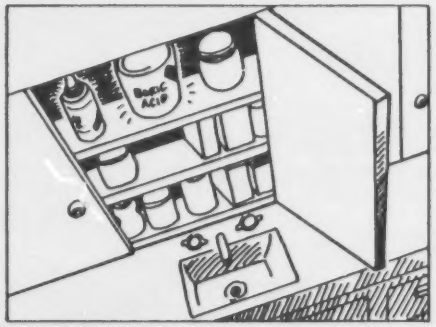
Dust under and behind the stove, washer, cabinets, & refrigerator.

Blow dust into all inaccessible cracks and openings in floors.

REMEMBER: First remove the roaches' food, water, and hiding places. Dust alone is never ENOUGH!

BORIC ACID IS A PESTICIDE AND A POISON. READ THE LABEL CAREFULLY!

- Do not apply near food, near food preparation areas, or on cooking pots, pans, or dishes.
- Do not apply to places that children or pets can reach.



- Store out of children's reach and away from food.
- Avoid inhaling the dust – and wash your hands after use.

TEXT: KATHLEEN LETCHER COWLES
ILLUSTRATION: LEE MARRS -
PRODUCED BY: CIAS, A DIVISION OF JMI, INC., UNDER A GRANT FROM THE C.S. MOTT FOUNDATION. MODIFIED FROM A BUREAU OF COMMUNITY SANITATION AND SAFETY · N.Y. STATE DEPT. OF HEALTH BROCHURE.

FOR FURTHER INFORMATION, CONTACT:

COCKROACHES

YOU CAN GET RID OF THEM!

HOW TO GET RID OF COCKROACHES

YOU WILL SEE :

BIG ONES

LITTLE ONES

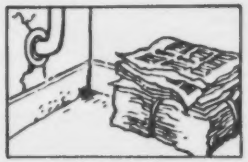
EGG CASES

TO LIVE AND MULTIPLY, COCKROACHES NEED:

- WATER

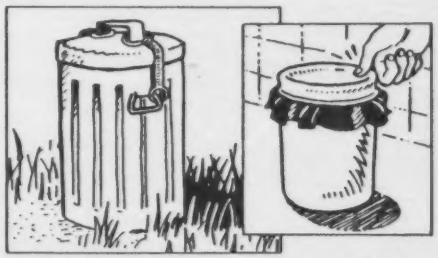
- FOOD

- HIDING PLACES



1. TAKE AWAY THEIR FOOD

Use containers with tight-fitting lids to store your flour, crackers, sugar, and cereal, or — keep it all in the refrigerator.

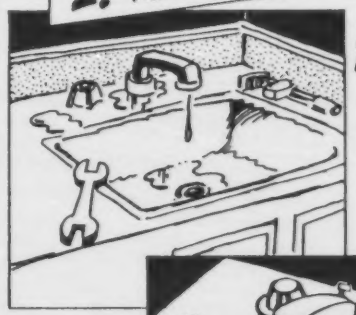


OUTDOORS: Put garbage in metal containers with tight covers or lid fasteners.
INDOORS: keep garbage in plastic containers with tight lids.

Wash your dishes, tables, & counters — at least daily.

Clean all storage shelves and drawers. Paint shelves with enamel. Do not use shelving paper.

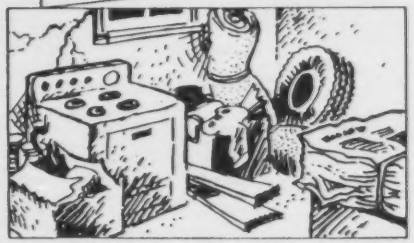
2. TAKE AWAY THEIR WATER



Fix all leaks.

Keep all areas clean and dry.

3. TAKE AWAY THEIR HIDING PLACES



CLEAN OUT JUNK AND CLUTTER!

- Throw out or recycle old newspapers, empty bottles, and cardboard boxes.
- Get rid of unused furniture, appliances, food, and clothing.

- Caulk ALL cracks and crevices.
- Seal openings around pipes.
- Remove chipped paint and loose wallpaper.
- Replace broken tiles.

THE FEAT BEAT

Cockroaches are always in season

Kathleen Letcher Cowles is Flint project coordinator for the John Muir Institute of California. Cowles is working with Flint residents to teach organic means of pest control.

What common Michigan wildlife is far more abundant than white-tailed deer, has an unlimited hunting season and can be found grazing in numerous urban kitchens? (Hint: These little critters have wings and six legs.)

As many city dwellers know all too well, this is the German cockroach, the most abundant of the four cockroach species found locally. Cockroaches have been on the planet 399 million years longer than humans, and are among the few creatures believed able to survive a nuclear war unscathed. With that sort of track record, it's not surprising that they're easy to bring into your home — and difficult to get rid of.

But cockroaches can be controlled safely and effectively by following a program that removes their sources of food and hiding places inside and then reduces the size of the remaining population through use of the least-hazardous roach insecticide. Here it is:

● STOP FEEDING your roaches. Store cereals, sugar and grains in the refrigerator or in clean jars with lids. Food wastes in the kitchen can be stored temporarily in a lidded plastic container and then removed to a lidded metal can outside. Avoid feeding your pests along with your pets by removing pet food after the animal has eaten.

● Don't invite roaches to dinner. Wash dishes immediately after meals, or submerge in hot soapy water if washing isn't possible. But be sure to wash your counter and stove tops daily. A little bit of food goes a long way for a hungry roach.

● Roaches live in cracks, especially cracks in warm areas near moisture and food. Inexpensive caulk fills the cracks up and gives roaches fewer places to hide — and breed. Water sources can be reduced by repairing or replacing leaky faucets and removing as much standing water as possible (such as in pet dishes or plant pots).

● INVEST IN cockroach traps, commonly known as "roach motels" — small cardboard boxes lined with a non-toxic chemical attractant and very sticky glue. If the roach trap is placed next to a wall or large kitchen appliance, roaches will enter the trap and die in the glue. By placing several roach traps in likely spots in your kitchen and bathrooms and then keeping a record of your "catches," you can determine which areas of your home still have roaches. Concentrate on these areas.

● Serious infestations of roaches may require insecticides, in addition to removal of food and hiding places. Most people find pesticide spray treatments to be expensive and ineffective. Wily roaches can smell the spray and retreat deeper into their hiding places, only to return when the spray has evaporated. Unfortunately, you and your family don't have the option of retreat and have to inhale the poisonous vapor as long as it lasts.

AN EFFECTIVE, safe and inexpensive alternative is insecticidal boric acid dust (available locally at Taber's Marathon at 1410 Detroit). Boric acid is most commonly dusted lightly in out-of-the-way cracks and under large appliances, especially the stove and refrigerator. Roaches walk through the dust and ingest the material while cleaning themselves. The material must be replaced if it becomes wet.

Because boric acid has no odor, roaches don't try to avoid it; and because it doesn't give off a vapor, you don't have to breathe it.

But remember: Any insecticide is poisonous and should be used with caution — and only when roach hiding and feeding places are being reduced. Even boric acid can't do the job all by itself.

Survey of Attitudes and Knowledge of Public Housing Residents Toward Cockroaches*

F. E. WOOD[1], W. H. ROBINSON[2], SANDRA K. KRAFT[3], AND PATRICIA A. ZUNGOLI[4]

[1, 3]Department of Entomology, University of Maryland, College Park, MD 20742; [2, 4]Department of Entomology, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061

ABSTRACT

A survey of 648 public housing residents in Roanoke and Norfolk, Virginia; and Baltimore, Maryland, was conducted to determine their attitudes toward, and their knowledge of household cockroaches. The survey included questions concerning causes and control of cockroaches, the number and location of cockroach sightings, and amount of money spent on pesticides.

The results of the survey show that the residents are concerned about cockroach infestations. Residents spent between 0.4% and 1.0% of their annual income on pesticides to supplement the pest control program provided by the individual housing authorities.

Fifty-one percent of those questioned thought the major cause of cockroaches was food and/or filth, but only 14% thought cleanliness was the best control measure. An additional 41% thought insecticides would best control cockroaches. Forty-seven percent of the residents considered seeing 2 cockroaches a problem.

Among other findings of the survey were: significant x^2 relationships between the number of cockroaches seen in 24 hours and the rating given to a cockroach control program, and whether residents perceived cockroaches as a serious problem, whether they thought cockroaches could be gotten rid of, and whether they purchased pesticides.

ESA BULLETIN Vol. 27, No. 1, 1981

This column, developed by the staff of the Center for the Integration of the Applied Sciences, a division of the John Muir Institute, under a Cooperative Agreement with the U.S. Environmental Protection Agency (EPA), will be a regular feature of the **IPM Practitioner.** Information contained in this column was not reviewed in advance by the EPA, and the authors are solely responsible for its contents.

Cockroach Management

Cockroaches are among the most disagreeable of domiciliary insects, inducing psychological distress and social embarrassment in those whose dwellings are infested. They consume and contaminate human foodstuffs with saliva and excrement and produce secretions which impart a characteristic fetid odor to materials they contact. Cockroaches vector a number of microbial organisms, including human pathogens such as *Salmonella* spp., *Toxoplasma* sp., and hepatitis B virus. Roaches also have been known to induce allergic reactions in humans.

Cockroaches have changed little since their beginnings in the Devonian period of the Paleozoic era 400 million years ago. In the world today, there are more than 3,500 known species, 57 of them in the United States. As many as 4,000 additional species are still undescribed. Cockroaches are found in caves, mines, animal burrows, and ant and termite nests, as well as human habitats.

Only four roach species are significantly pestiferous: the German, brown-banded, oriental, and American. Their abilities to hide by day in small cracks and crevices in or near human dwellings and to feed by night on water and small bits of food and waste have made these four species highly successful human cohabitants.

Cockroaches evolved as scavengers on dead plant material and as a result prefer carbohydrates to protein and fat. They will discriminate if given a choice but when hungry will eat almost anything. Some products that are not usually considered food—such as starch-based paints, wallpaper paste, envelope glue, and bar soaps—contain carbohydrates, hence are food for roaches. Buildings provide cockroaches with microclimates similar to their native habitats. Most important to their survival is a source of moisture and warmth, although some species, particularly the brown-banded, are adapting to require less heat and water.

Cockroach infestations can occur in any home and are often accidently introduced as egg cases in shipped materials, groceries, or secondhand appliances, rugs, furniture, etc.

See table 1 for distinguishing characteristics and preferred habitat and microclimate of each of the four domiciliary species of roach.

Monitoring Techniques Direct and Evaluate Treatments

Monitoring and record keeping show (1) where cockroach population density is highest and, therefore, where habitat modification efforts should be concentrated, and (2) whether these efforts are actually reducing the cockroach population. A nontoxic cockroach trap developed by the Zoecon Corporation, a division of Occidental Chemical Company, is useful for monitoring purposes. Sold commercially under a variety of trade names, it consists of a small, rectangular cardboard box, inside of which are three bands of

Table 1—Characteristics of Domiciliary Cockroaches

	German *Blattella germanica*	Brown-banded *Supella longipalpa*	Oriental *Blatta orientalis*	American *Periplaneta americana*
Color and characteristic markings	Light brown with two dark stripes on the pronotum (platelike structure behind the head or the back)	Tan-golden with faint V-shaped lighter bands on the wings	Dark red brown-black throughout	Reddish brown throughout with a pale band on the edge of the pronotum
Length (in inches)	9/16	9/16	1¼	1¾
Average number of eggs/egg case[1]	37	16	18	14
Number of egg cases/female	4–8 (6 average)	5–18 (12 average)	5–10 (8 average)	6–28 (17 average)
Life cycle (in days from egg to adult)	64–251	143–379	215–991	320–1071
Reproduction characteristics	Female carries egg case until 1–2 days before hatching, then drops it anywhere	Egg case glued to ceilings, beneath furniture, or in closets or other dark places	Egg case is deposited in debris or food in a sheltered place	Egg case deposited in sheltered area on or near floor, close to food source, concealed in debris. High humidity required for hatching.
Preferred habitat indoors	Warm moist areas in food establishments and other buildings where food, warmth, and moisture are readily available. Prefers the kitchen and bathroom	Found throughout the house. Prefers high locations in heated homes, apartments, hospitals. Also under furniture, in appliances that generate heat, behind wallpaper, in desks, dressers, boxes, piles of debris, material, in closets	Crawl spaces, basements, under refrigerators, washing machines, sinks. Usually found below ground level	Found in commercial buildings, such as food establishments, grocery stores, warehouses, office buildings, prisons, or ships. Prefers warm moist areas around furnaces or heating ducts. Usually found in basement or first floor
Natural enemy parasites[2]	Miniwasp *Tetrastichus hagenowii* (Ratzeburg)	Miniwasp egg parasite *Comperia merceti* (Compere) and *Aunstatus blattidarum* Ferriere	Miniwasp *Tetrastichus hagenowii* (Ratzeburg)	Miniwasp *Tetrastichus hagenowii* (Ratzeburg)

[1]The number actually hatched can be fewer.

[2]Cockroaches are generally fed upon by predatory spiders, ants, rats, wasps, toads, beetles, bugs, mantids, dragonflies, scorpions, and a pterygosomid mite *Pimeliaphilus podapolipharus* Trägardh.

a sticky glue and a dark strip of cockroach attractant. Initial observations indicate that it is quite attractive to the German roach but less so to the brown-banded.

Cockroaches prefer enclosed spaces and usually travel along the periphery of walls and other objects. Thus, trap placement is most important, for roaches will not seek traps out if they are placed outside their normal travel areas.

Cockroach feces, called *frass*, look like grains of pepper and, particularly for the brown-banded, can be used to discover favored locations. Pyrethrin sprays can be used to flush out populations behind appliances and in hard-to-reach areas, but this method should be used only if trapping or visual inspections have been unsuccessful (a respirator should be worn while spraying).

By keeping records of numbers and lifestages of cockroaches trapped, numbers killed, and egg cases found, one can tell if a treated situation is improving. Many adults and egg cases indicate the habitat can still support reproduction. Small nymphs with few adults may indicate a population decline, as egg cases will continue to hatch over time after the adult population has been reduced.

Injury Levels

Tolerance of roach populations varies a great deal according to the type of institution (warehouses may be more tolerant than restaurants), standards of sanitation, and individual predilection (some persons are highly excited by even small numbers of insects). However, high population levels represent health risks from microbial species harbored by roaches.

Habitat Modification: Indoors and Outdoors

Reduction of food, water, and harborage are critical in cockroach management. These factors affect the carrying capacity of the environment. If they can be reduced, the ability of the room, house, or structure to support roaches is reduced, hence fewer roaches occur.

Food

To remove sources of food, clean up the kitchen, especially after each meal and in areas where grease accumulates, such as drains, vents, ovens, and stoves. Store all food, especially sweet, starchy, or fatty food, in tightly sealed metal, glass, or heavy plastic containers, as cockroaches can infest food in open bags or cardboard or cloth containers. Empty household garbage and pet litter boxes regularly and wash dirty dishes or submerge them in sudsy water before retiring at night. Don't leave pet food out between feedings.

Water

Fix dripping faucets and any other leaks. Provide drainage or ventilation to eliminate moist areas. Do not leave water on kitchen surfaces and remove pet water bowls at night.

Harborage

When cockroach harborages are found, accessible areas can be washed down and vacuumed to eliminate egg cases, fecal material, and bits of food waste that may have accumulated. Suspected materials also can be steam-cleaned. Dispose of vacuumings by burning or deeply burying, or place in tightly closed containers for disposal, or compost after safe disinfection (e.g., use of household ammonia).

Plug all small cracks around baseboards, wall shelves or cupboards, pipes, sinks, and bathtub fixtures with putty or caulk (paint may also be used alone or in conjunction with either of these). Three general types of caulk are available: (1) cartridge caulk (which requires a caulking gun—see figure 0) is useful for big jobs, such as along floor boards or behind cabinets; (2) squeeze tube caulk is good for sealing around water faucets, vents, etc.; and (3) rope-like caulk is most useful for quick temporary seals and hard-to-reach spaces. Latex caulk is best because it is water soluble before drying and, once dry, stays flexible. Although new urethane foams in aerosol cans are available, they are difficult to use.

Large holes or cracks will require special cements or other substances which match existing materials, depending upon how visible the repairs will be. In older dwellings with many cracks, crevices, and hard-to-reach places, start by concentrating on kitchen and bath areas, or wherever populations are heaviest. Work on these areas as time and energy allow. Every five inches of hiding place plugged up reduces the number of roaches a house can support.

Caulk or weatherstrip cracks and crevices through which pests can enter the home, replace broken windows and screens, and seal door frames. Screen all air vents, particularly those in the kitchen around the stove.

Reduce outdoor roach populations by moving debris, firewood, and garbage away from the house. Prevent access to indoor spaces with screens. Commonly available aluminum window screen is adequate to repair existing screens. Silicone seal is an excellent material for filling holes in window screens. Compost or bury pet manure, or use a commercial pet waste disposal system. Use garbage cans with tightly fitting lids held on by a spring mechanism to prevent wind and dogs or other animals from scattering the contents.

Use of Insecticides

Serious infestations of roaches may require insecticide use in addition to habitat modification. Safety, effectiveness, and pest resistance are the main factors to consider in selecting a poison. Cockroaches are repelled by pesticides they can smell but are least repelled by boric acid (BA) and have not developed resistance in over 10 years of use. This material is commonly available at pharmacies.

Although boric acid can be diluted and applied as a wash, it is more effective as a dust. Roaches walk through the dust and ingest the material while cleaning themselves. Thereafter, BA operates slowly, killing in 7 to 14 days. In addition, BA applied as a dust does not readily vaporize. In the kitchen, use BA dust where habitat modification is difficult—around the stove and refrigerator or in particularly difficult cracks. This material can also be blown into wall voids, although here there is a hazard to personnel involved in reconstruction at a later date since BA can be poisonous to people. About one ingested tablespoon can kill a child. BA can also be absorbed through skin lesions or respired. Wear a dust mask if application methods throw boric acid dust into the air. Keep boric acid away from food, children, and pets. Label and seal storage containers carefully.

Resist the temptation to turn to an insecticide as an easy way to avoid necessary habitat modification. Make the needed permanent changes in the environment first; then use an insecticide, if the changes alone are not sufficient.

Summary of Cockroach IPM Program

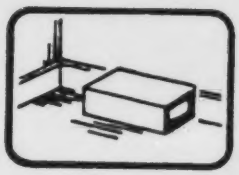
1. Know the biology of cockroaches.
2. Use traps for detection of heavy infestations.
3. Keep records of catches to evaluate effectiveness of treatments.
4. Reduce carrying capacity of the environment by eliminating food, water, and harborage.
5. Focus caulking and filling of cracks and crevices where highest roach densities occur.
6. Use boric acid, as a dust, in areas where habitat modification cannot be applied. Boric acid is a poison and should be used with caution.
7. Teach others the program.

HOW TO USE TRAPS FOR SURVEYING COCKROACHES

1. Traps should be placed in all rooms suspected of having roaches plus all food and waste handling areas and bathrooms.

2. Place 1 to 2 traps per room (up to 10 traps in a large food handling area) on the floor and on shelves. German, American, and Brown-banded roaches can be caught on the floor or shelves. Oriental roaches rarely climb onto shelves.

3. Place traps broad side down.



4. Check traps regularly to determine the severity of the roach infestation (and/or the effectiveness of your treatments).

5. After checking the traps, replace them with new traps or turn the used traps over so that the opposite broad side is on the bottom. Since there are only two broad sides to most traps, they can only be turned once before they are no longer useful for surveying; however, they can still be used for roach suppression.

COCKROACH CONTROL IN FOUR STEPS

Step 1. Sanitation

This includes keeping food and wastes away from roaches by cleaning, using snap containers with no access holes, etc.

Step 2. Habitat Modification

Roaches prefer to live in narrow spaces such as cracks and crevices. Caulking and plastering these spaces eliminates this habitat and reduces the number of roaches that can live in the immediate area.

Roaches also need moisture and like damp areas. All leaky faucets, sinks and drains should be repaired to make the habitat less favorable.

Step 3. Barriers/Exclusion

Open vents and windows give roaches access from one area to another. These should be screened to prevent free movement of the insects.

Roaches often hide in dark, undisturbed areas. They prefer to deposit their egg cases in such places as well. Some roach species drop their egg cases just before offspring are to hatch. Others attach their egg cases onto out-of-the-way surfaces weeks before hatching. Sometimes adults and egg cases can be found between flaps of paper bags and cardboard boxes as well as underneath and within furniture such as sofas and cabinets. Such items should be checked before moving them, especially when moving from a roach infested location to one which is not infested.

Step 4. Direct Suppression

a. Trapping

Traps, such as Roach Motels^{R}, can be used to reduce roach populations. They are most practical for this purpose in areas with low infestations and where insecticides are unadvised (counters, etc.)

Traps can be used at any time to monitor a roach population. They can give an indication of relative number and location of an infestation.

b. Poisoning

In addition to the above treatments, an insecticide may be necessary if the infestation is severe. However, an insecticide will only temporarily reduce a roach population. Permanent reduction and possible elimination will occur only if the other steps are taken.

Products containing only boric acid as the active ingredient are the most effective roach insecticides. 1981 tests conducted by W. Todaro in Pittsburgh, PA, public housing units recently confirmed this to be the case. (A comparison chart of boric acid products follows.) They are also the least toxic to humans and mammals.

The only recommended insecticides, other than boric acid, are microencapsulated pyrethrins. (Microencapsulation reduces toxic hazard considerably.) These should be used only if an area is frequently damp, a condition which causes boric acid to lose its effectiveness, and after all the preceeding treatment options have been implemented.

All pesticides should be handled with care. Always follow label instructions. Be sure to store the poison out of the reach of children and pets.

Cockroach

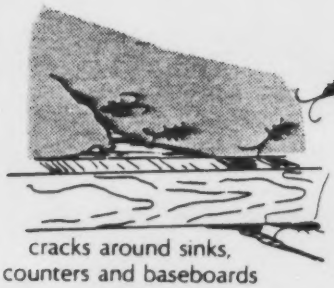
Likes

food in open trash containers

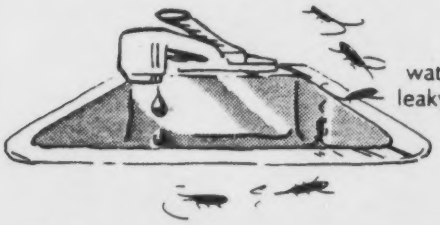
food left on counters and stoves and dirty dishes

food stored in boxes

pet food left out



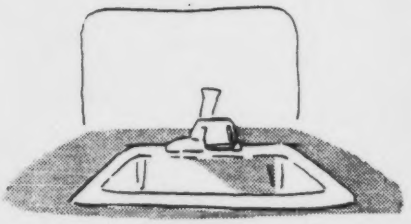
cracks around sinks, counters and baseboards to hide in



water from leaky faucets

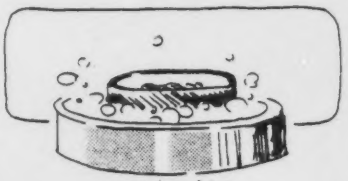
Dislikes

lids on food garbage containers

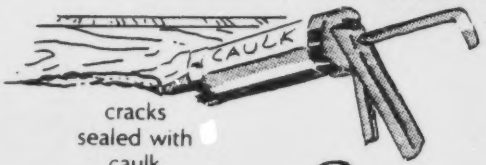


clean counters with dishes washed or soaking in soapy water

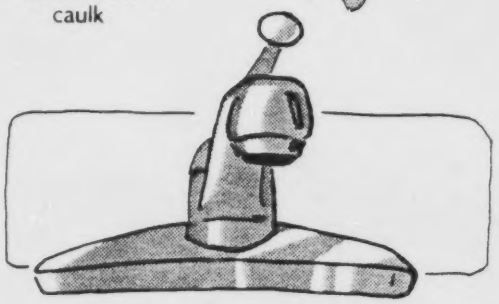
food stored in sealed containers



pet food in a bowl of soapy water



cracks sealed with caulk



leaky faucets repaired

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RETAILER'S CHART FOR COMPARING SOME INSECTICIDAL BORIC ACID PRODUCTS

PRODUCT/MANUFACTURER	WHOLESALE $/POUND	QUANTITY	% BORIC ACID % OTHER	TYPE OF CONTAINER	PROFESSIONAL APPEARANCE
"Roach Killll" Norshore Dist. Co.	1.58	25 lb. Bulk pail	99% Boric acid 1% ?	Bulk pail (retailer must pkg.)	---
"Roach Away" Willert Home Products	1.80	Case of 12, 8 oz. bottles	99% Boric acid 1% Inert	Plastic squeeze bottle w/cap	Yes
"Wipe Out" Wilbert Products Co., Inc.	2.36	Case of 12, 8 oz. cans	99% Boric acid 1% Inert	Can with plastic resealable top	Yes
"Doc Edmonds Roach Powder" North Carolina Chemical Co.	2.50	Case of 36, 15 oz. pkgs.	98% Boric acid 2% Inert	Cardboard container	No. Packages not sturdy.
"Roach Kil" R Value Inc.	2.60	Case of 12, 22 oz. bottles	99% Boric acid 1% Inert	Plastic bottle, screw-on lid & applicator brush	Yes
"Roach Killll" Norshore Distributing Co.	2.72	Case of 24, 16 oz. cans	99% Boric acid 1% ?	Shaker top can	Yes
"Roach Kil" R Value Inc.	3.80	Case of 12, 10 oz. bottles	99% Boric Acid 1% Inert	Plastic squeeze bottle	Yes
"Neva-Mor Roach Powder" Rago Products Inc.	4.77	Case of 24, 16 oz. cans	99% Boric acid 1% Inert	Can	Yes
"Mr. Cucaracha" Ramick Chemicals	4.80	Case of 12, 10 oz. bottles	98.85% Boric acid 0.15% Methyl Myristate, 1% Inert	Plastic bottle, screw-on cap	Yes
"Roach Prufe" Copper Brite, Inc.	5.00	Case of 120 16 oz. cans	99% Boric acid 1% Inert	Non-resealable can	Yes
"Roach Free" Organic Distributors	5.85	Case of 12, 16 oz. bottles	99% Boric acid 1% Drying agent	Plastic squeeze bottle w/flip top	Yes
"Wheat Roach Super Shot" Wheat's Roach Shot	7.00	Case of 108 (minimum) 8 oz. bottles	97% Boric acid 2% Pyrethrine 1% Inert	Plastic squeeze bottle w/reseal-able cap	No. Bottle good but label hard to read (poor printing quality)
"Nott Roach Powder" Nott Mfg. Co.	7.33	5 oz. cans		Steel can, resealable	Yes

CIAS/JMI 12/81
Revised 8/82

Note: This chart is a partial compilation of boric acid insecticide distributors developed to acquaint merchants with some information about boric acid products. The information is as accurate as possible as of December, 1981; however, CIAS/JMI cannot assume liability for errors or omissions. Purchasers are urged to contact manufacturers for further up-to-date information. Experience in the field indicates that plastic squeeze bottles are the easiest containers to use to apply the dust, while the can containers are more difficult to use.

BORIC ACID DISTRIBUTORS

Doc Edmond's Roach Powder
North Carolina Chemical Company
P.O. Box 294
Belmont, North Carolina 28012
(704) 825-9392
attn: John L. Haney

Mr. Cucaracha
Ramick Chemicals
P.O. Box 19289
Washington, D.C. 20036
(202) 387-3977
attn: Michael J. Levy

Neva-Mor Roach Powder
Rago Products Inc.
597 Crescent Avenue
Bronx, New York 10458
(212) 933-5343
attn: Peter Rago

Nott Roach Powder
Nott Manufacturing Company
Pleasant View Road
Pleasant Valley, New York 12569
(914) 635-3243

Roach Away
Willert Home Products
4044 Park Avenue
St. Louis, Missouri 63110
(314) 772-2822
attn: John E. Mullin

Roach Free
Organic Distributors
P.O. Box 1367
Conroe, Texas 77305
(713) 756-6351
(713) 588-1047
attn: Sally Connelly

Roach Kil
R Value Inc.
3128 Nifda Drive
Smyrna, Georgia 30080
(404) 355-9366

Roach Killll
Certox
Distributed by:
Norshore Distributing Company
P.O. Box 162
Lake Forest, Illinois 60045
(312) 234-4800
attn: Joe Farmer

Roach Prufe
Copper Brite Inc.
5147 W. Jefferson Blvd.
Los Angeles, California 90016
(213) 933-9331
attn: Alan Brite

S.A.J. Borated Powder
907 American Avenue
Waukesha, Wisconsin 53186
(414) 542-9169
attn: Shiela Johnson

Wheat Roach Super Shot
Wheat's Roach Shot
2008 S. Central Avenue
Los Angeles, California 90006

Wipe Out
Wilbert Products Company, Inc.
805 E. 139th Street
New York, New York 10454
(212) 292-8200
attn: Robert E. Gamber

BORIC ACID POWDER FOR COCKROACH CONTROL

By Walter Ebeling, Professor
Department of Entomology, Los Angeles

You can use boric acid powder to control cockroach infestations in homes and other buildings. It is available as proprietary powders (compounds sold over the counter), which contain a 1-percent additive that makes it easier to spread the material. If the boric acid does not contain an additive (as when purchased in drugstores), pass the powder through a sieve or screen to break up the lumps. When handled properly, boric acid is not highly toxic to humans.

You can apply boric acid powder with bulb dusters, the Getz Powder Blower, or with plastic dispensers or squeeze bottles.

Place the powder where the insects spend most of their time. Cockroaches seek out warm, dark, hard-to-get-at places. In kitchens, favorite hiding places are under and behind refrigerators, stoves, and sinks. Other ideal hiding places are hollow, dark areas-in walls or under cabinets, closets, and bookcases.

For good coverage with boric acid powder, remove the kick panels on refrigerators and stoves and apply a film of dust throughout the entire area underneath these appliances. It is advisable, at least in old buildings, to drill 1/2" holes at the tops of kick panels beneath cabinets. Apply the powder liberally to these areas as well as under the sink, in the dead space between the sink and the wall, and around utility pipes. Also treat along the back edges and in the corners of shelves in cabinets, cupboards, pantries, and closets and in cracks and crevices everywhere.

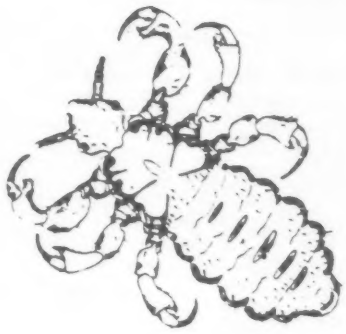
Boric acid powder does not decompose rapidly and is effective for as long as it is left in place. However, if the powder gets wet and then dries again, such as under a refrigerator or sink, it adheres too firmly and is not readily picked up by the cockroaches. If this occurs, re-apply the powder to these areas.

For effective, lasting control, you need 1 to 2 pounds of boric acid powder for an apartment and 2 to 4 pounds for an average size house. For restaurants, cafeterias, hotels, and hospitals, 30 to 40 pounds of boric acid powder may be required.

CAUTION: When using boric acid, carefully read and follow all precautions given on the label. Like other inorganic compounds, boric acid does not penetrate the skin to a high degree, but you should wear gloves during prolonged periods of contact with the powder. There are no toxic vapors, but be careful not to inhale the dust during application. In open areas frequented by small children and pets, do not leave more then 1/2 teaspoonful of powder in any one spot. Do not apply where children or pets might eat the powder. Keep the powder in the original labeled container and store in a safe place out of the reach of children, unauthorized persons, and pets.

Do not apply boric acid to plants, soil that contains plants, or where air currents may carry the material to plantings. Most plants have a very low tolerance for this material and may be severely burned or killed if the soil is contaminated with it.

Integrated Pest Management
for
HEAD LICE



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URBAN ECOSYSTEM MANAGEMENT

This column, developed by the staff of the Center for the Integration of the Applied Sciences, a division of the John Muir Institute, under a Cooperative Agreement with the U.S. Environmental Protection Agency (EPA), will be a regular feature of **The IPM Practitioner**. Information contained in this column was not reviewed in advance by the EPA and the authors are solely responsible for its contents.

Using IPM Principles for Managing Head Lice

Head lice are a common pest problem in schools in major U.S. cities. The widespread practice of applying insecticides unnecessarily to entire school buildings has led to the development of populations of head lice resistant to insecticides and the regular occurrence of lindane, the most common pediculicide, in human tissues. Under these circumstances, an IPM approach is certainly indicated for head lice management.

Head lice are becoming more common throughout the world, especially in school-aged children. Resistance to lindane (the gamma isomer of benzene hexachloride, or BHC), the active ingredient in most insecticides now used against head lice, may be widespread. Resistance is known from England and the Netherlands, probably occurs as well in Denmark, Hungary, South Africa, and the United States, and doubtless could be found in many other areas if resistance testing were done more systematically.

As lindane can be absorbed through the skin, acute toxic overexposures from the use of this material have been recorded. Furthermore, lindane is common recovered in human fat tissues, and the long-term health implications of small doses are not fully understood; thus, all unnecessary exposures should be avoided as a general rule.

Biological Characteristics of Human Lice

There are only two major groups of lice in the animal kingdom: the biting lice in the insect order Mallophaga, and the sucking lice in the order Anoplura. Biting lice are found on both mammals and birds (e.g. chickens), while sucking lice occur only on mammals, including humans.The three sucking lice species which feed on humans are: the head louse *Pediculus capitis*, the body louse *P. humanus*, and the pubic louse *Pthirus pubis*. Each of these has a characteristic pattern of occurence on the human body. Proper identification of the species of "pest" with which one is dealing, so that treatments can be accurate and timely, is one of the basic principles of IPM. Accurate identification of lice species is, therefore, critical for proper treatment.

Head lice are found most often on young school-age children, occasionally on older children or adults, and sometimes among people in psychiatric care facilities, jails, or related institutions. The eggs, or nits, of head lice are found glued tightly to hairs, most often around the back of the ears and the nape of the neck. The adults can be found in the same areas but also on other head areas, including eyelashes, and on other body hairs. Adult head lice have been found on headgear, combs, brushes, and scarves.

Body lice, on the other hand, live, not on the head, but on clothing, move to the body to feed, and return to clothing to lay their eggs. They are most common on indigent adults who habitually sleep in their clothes. Persons who regularly carry large infestations develop hard, pigmented skin areas, the condition known as *vagabonds' disease*. Body lice are commonly called "cooties," "graybacks," or "mechanized dandruff." Head and body lice are known to interbreed, resulting in intermediate forms, but pubic lice cannot mate with either of these species. Body lice are probably the sole agent in the transmission of the deadly epidemic typhus caused by *Rickettsia prowazeki*. In addition, body lice also vector epidemic relapsing fever, also called louse-borne typhus (LBT), caused by the spirochete *Borellia recurrentis*. LBT killed at least three million Russians during World War II; eighty-one percent mortality rates were reported in

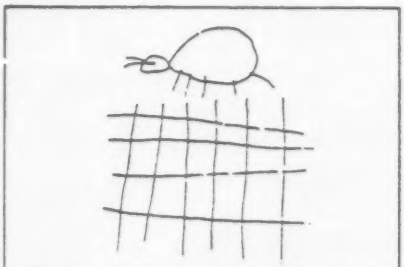


Fig. 1. Hobo drawing of "cootie" to indicate lice in jail

Italy at the same time. Head lice and pubic lice have not been proved to transmit any diseases, but they have been incriminated and should not categorically be dismissed as possible vectors. For a condensed history of disease transmission, consult *Herm's Medical Entomology*, by M.T. James and R.F. Harwood, 6th ed., MacMillan Co., London, 1969. The sizes, development times, and reproductive rates for the three different lice species are shown in Table 1.

Table 1.—*Some Biological Characteristics of the Three Human Lice Species*

Louse species	size, (mm.)	egg to egg development time (days)	no. eggs/ female
Pubic	1.3–3	22–27	30
Head	2–4	approx. 21	50–100
Body	2–4	approx. 21	275–300 (10/day for 20–30 days)

Pubic lice, sometimes called "crabs," are sometimes found on young children on eyelashes and on head hair around the hairline. Most commonly, pubic lice are found on young adults in the pubic regions, but they also occur in the armpits and, more rarely, on other parts of the body such as beard, moustache, eyebrows, and eyelashes. Pubic lice infestations have been reported on dogs but this occurrence is rare. All three types of lice originate on humans and are transmitted by direct or indirect contact between humans only.

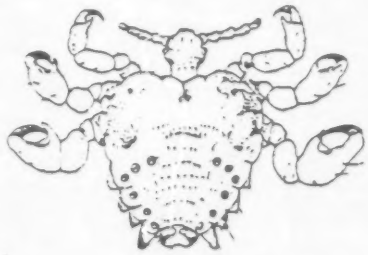


Fig. 2. Pubic louse *Pthirus pubis*

Monitoring Techniques

Excessive scratching; skin irritation or inflammation from bites; accumulation of louse fecal matter on shoulders, especially visible on light-colored clothing; infected and scabbing skin areas in heavy infestations; presence of nits, nymphs (=immatures), and adult lice in head hair —these can all be used to detect infestations. Regular inspections conducted by school health personnel for presence of lice, or their signs, can be an important part of a good IPM program.

Nontoxic Treatments for Head Lice Control

Contrary to popular opinion, anyone can acquire lice, regardless of his or her level of cleanliness. Only the body louse can be eliminated by ordinary cleaning

practices, i.e., frequent bathing and regular changes of bedding and clothing. Normal hair combing or washing cannot eliminate an infestation of head lice, although these practices may be helpful as a general prevention technique. Shampooing with a coconut oil–based soap could be useful, since dodecyl alcohol, derived from coconut oil, kills adults and some eggs. Old-fashioned "Green Soap" has a coconut base but is not a commonly available commodity. No other shampoos or soaps which do not contain an insecticide are known to be effective in removing lice or their eggs.

Perspiration induced by exercise will repel body lice, so strenuous activity may prevent or alleviate infestations. Since head lice are highly sensitive to temperature changes, saunas, hot water, or steam baths may also be useful, but no data exist to indicate they can be used effectively. Such physical treatments would be most desirable and should be tested when the opportunity occurs.

Habitat modification may also play a part in an IPM program for head lice. One early worker reported that girls were told to braid their hair before going to school and to unbraid it and comb it out upon returning home as a preventative technique. There is research showing that children whose clothes were hung on assigned hooks or who used individual lockers had significantly fewer head lice infestations than children who used unassigned hooks or shared lockers. Shaving of head hair was practiced effectively by military, religious, and other organizations to control head lice, but this procedure can stigmatize children unnecessarily. It is true that shorter hair styles may act as a preventative technique, since they allow light to reach the scalp, and lice avoid light. They should not, however, be forced on children but suggested as a possible alternative.

Head lice infestations, once they have occurred, can be eliminated by handpicking. The procedure must be followed once a day for up to 12 days, since nits will continue to hatch for 8 to 11 days. This procedure involves an intensive systematic search of the head and eyebrow hair and removal of all eggs, young, and adult lice. See figure 3 for information about distinguishing live and hatched nits (hatched nits are empty shells, hence inconsequential). Nits can be removed by pinching with long fingernails or pulled with forceps. Eggs and other lice stages can be killed by dropping in boiling water. As human pathogens are transmitted by crushing lice, this method of killing should be avoided. Manual removal of nits requires a skilled hand and eye, since the nits can easily be missed during searching. On the other hand, the procedure costs nothing but time, is completely safe, and can be

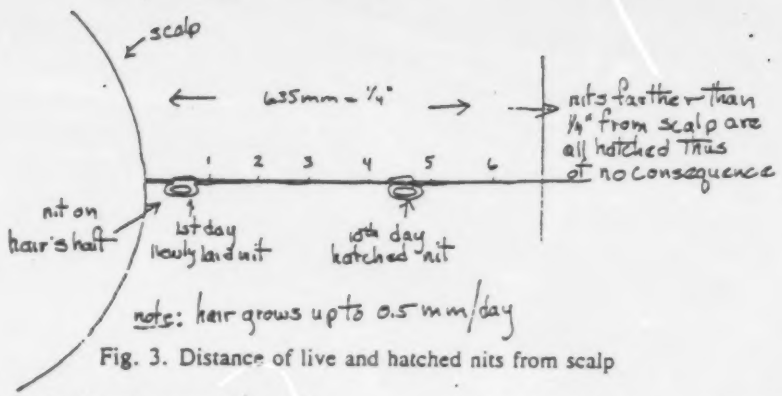

scalp
6.35mm = ¼"
nits farther than ¼" from scalp are all hatched Thus of no consequence
1 2 3 4 5 6
nit on hair's shaft
1st day newly laid nit
10th day hatched nit
note: hair grows up to 0.5 mm/day

Fig. 3. Distance of live and hatched nits from scalp

enjoyable for both parties involved.

Head lice can also be removed mechanically with a special fine-toothed comb. The metal Derbac® comb is widely available for this purpose. This comb has teeth set about 0.1 mm apart, wide enough to allow passage of hair but narrow enough to pull nits off the hairs. Some hair may be thinned by this procedure. If the local pharmacy cannot supply you with the Derbac® comb, write to the manufacturer for information: Cereal Soaps Company, Division Johanson Manufacturing Corp., Box 329, Boonton, NJ 07005. Success has also been reported using other kinds of very fine combs, including those available in pet shops for combing fleas from cats and dogs.

Once lice have been eliminated on the human host, no other measures are strictly necessary. However, if one feels the need to deal directly with those lice which may still remain in the environment, vacuuming of rugs, floors, and furniture, and washing or dry cleaning of clothes and bedding can be useful. Storage of affected clothes and bedding for 30 days will also suffice to kill all lice and nits. It should be remembered that the concern many people feel with cleaning activities when head lice have been discovered reflects a confusion between head lice, which cannot be prevented by ordinary hygiene, and body lice, which can. IPM principl: #1: identification of the pest is the first step towards proper methods of control.

Summary of Head Lice IPM Program

1. Shampoo with coconut oil-based shampoo.
2. Comb nits out nightly with Derbac® or similar fine-toothed comb for period up to 12 days.
3. Monitor head hair regularly for new infestations.
4. Provide each child with separate storage space for head coverings or other clothing at school
5. Vacuum areas in schools where infested clothing has been stored. There is no evidence that pesticide treatment of the physical environment is effective in controlling head lice.
6. Use pesticidal shampoo preparations only as a last resort when combing alone is not effective. **Select pyrethrin-based rather than lindane-containing materials when pesticide use is determined to be necessary.** Pyrethrins must be 0.30%; lower percentages are not effective.

Acknowledgements

The major source for this report was the article by B. Keh, "Answers to Some Questions Frequently Asked about Pediculosis," *California Vector Views* 26(5/6): 51–62 (1979) and consultation with the author. Thanks also to Chris Jenkins and Linda Laub, CIAS members who contributed observations recorded in this report.

W.O. and H.O.

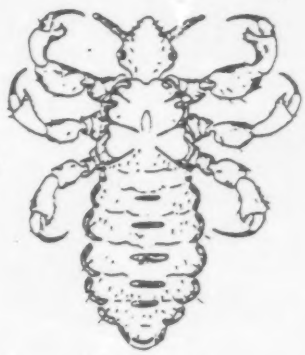


Fig. 4. Head Louse *Pediculus capitis*

SOME NUMBERS TO REMEMBER

Survival away from host

Pubic lice—1 day.

Head lice, body lice—usually 3 days (but not over 10 days under best conditions).

Head Lice

Eggs will usually hatch in 8–11 days.

Eggs more than ¼" from scalp have hatched and are of no concern.

Heat to kill eggs and lice

Wash in water 140°F (60°C) for 20 minutes.

Storage

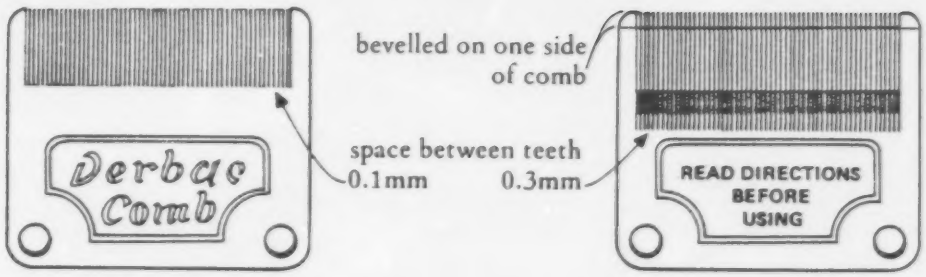
Storage of items for 30 days will assure that no eggs or lice will survive.

(From B. Keh, "Answers to some questions frequently asked about pediculosis," *California Vector Views* 26 (5/6):51-62.)

CONTROL OF HEAD LICE BY COMBING

Equipment Needed

1. 2-3 Towels
2. Shampoo
3. Clean hair brush
4. Clean large toothed comb
5. 30-40 Hair clips
6. Derbac louse comb



Side One

Side Two

What kind of combs can be used to effectively remove nits?

The removal by combing depends upon the use of a comb whose teeth are separated by spaces narrower than the width of the nits. A nit is 0.3 mm wide.

There are two general types of fine-tooth combs—plastic ones and metal ones. The available plastic combs I have seen have teeth set too far apart to be effective—the Derbac comb is metal and has teeth about 0.1 mm apart, which is wide enough for the hair to pass but narrow enough to keep out the nit. It is necessary to follow the directions which accompany the comb rather carefully to ensure success.[1]

DERBAC COMB
AT YOUR DRUGGIST OR
CEREAL SOAPS DIVISION
Johanson Manufacturing Corp.
P.O. BOX 329, BOONTON, N.J. 07005
201 - 334-2676

FREE: Special leaflet, poster, etc., for educational work to Doctors, Nurses and Teachers.

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[1] Vector Biology and Control Section, California Department of Health Services, 2151 Berkeley Way, Berkeley, CA 94704.

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7. Blow dry hair dryer
8. Box of tissues
9. Bowl filled with hot sudsy water
10. Spray bottle with water
11. Something for the child to do (books, crayons, etc.)

Combing Instructions

1. Shampoo hair vigorously.

2. Wrap towel around sudsy hair and leave on for 30 minutes.

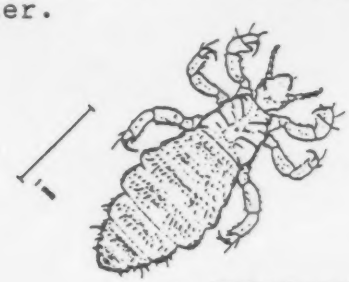
3. Comb hair with a LARGE TOOTHED COMB. (Keep hair wet.)

4. Comb hair with a specially designed LICE COMB until each strand has been done.

   a. Give child something to do (T.V., book, coloring, etc.)

   b. Take only a very small amount of hair, clip rest of hair out of the way; comb the strand with the angled edge of comb toward scalp; put a hair clip on the combed strands so you know which area has been done.

   c. Remove head lice, nits, hairs and soap suds from comb with a tissue; submerge all into a bowl of hot sudsy water.



   d. Pour bowl of water, tissues and debris into toilet periodically and flush; refill bowl with hot sudsy water.

   e. If hair dries, wet again with shampoo and water (spray bottle may be helpful); hair MUST be wet and sudsy.

5. Shampoo hair again and blow dry.

6. Check head and remove any remaining nits.

7. Boil comb, hair clips and brush in water for 10 minutes.

Post-Combing Instructions

1. Wash hair every day for two weeks.

2. Wash all dirty clothing, jackets, coats, hats, sheets, blankets, etc. so patient is not reinfested. (Head lice can only live for approximately two days off the human head. Household articles and clothing would contain only dead head lice after several days).

3. Vacuum tops of chairs, sofa, sofa pillows, etc. that are used by all members of the family.

4. Clean all combs, brushes - boil in water for ten minutes if possible.

5. Do not share combs, brushes, hats, etc. even between family members.

6. Make sure the child has his/her own hook on which to hang belongings at school.

Ten Easy Steps to Clean Infected Heads

Shampoo hair with Derbac Soap and leave thick lather on head.

Tie towel around lathered head and leave for half hour.

Remove towel. Hair is moist with soap. Leave it this way. Do not rinse.

Comb hair with regular comb to get out snarls.

Separate one inch strand of hair.

Hold strand away from head, and with Derbac Comb in slanting position, comb until every nit is removed.

Pin up clean strand. Start next strand and comb same way.

It takes two or more hours of combing to remove all nits. Hair must be kept wet while combing.

When all nits are removed, shampoo hair again. Rinse thoroughly and dry.

After hair is dry, examine carefully for stray nits and remove.

FOR MORE DETAILED DIRECTIONS READ "INSTRUCTIONS TO PARENTS" LEAFLET.

CEREAL SOAPS DIVISION JOHANSON MANUFACTURING CORP.
DERBAC SERVICE P.O. BOX 329 · BOONTON, N. J. 07005

Prepared April, 1981.

PESTICIDE HEALTH HAZARD DATA SHEET

Common Name	LINDANE
Trade Names	Exagama^{R}, Forlin^{R}, Gallogama^{R}, Gammaphex^{R}, Gammalin^{R}, Gammex^{R}, Gammexane^{R}, Inexit^{R}, Kwell^{R}, Lindafor^{R}, Lindagerm^{R}, Lindagrain^{R}, Novigam^{R}
Registered Uses (partial list)	Lindane is used widely in agriculture on fruits, vegetables and agrains against aphids, lygus bugs, grasshoppers, leafminers and many others. It is used in veterinary medicine against ectoparasites and is the active ingredient in Kwell^{R} shampoo and cream, used against human lice and scabies.
Type of Chemical	Organochlorine (chlorinated hydrocarbon)
LD_{50}	Acute oral: 88 mg/kg in male rats. Thomson, W.T., 1977. Agricultural Chemicals, Thomson Publications, Fresno, CA.
Regulatory Status	RPAR issued 2/17/77. In July, 1980 the Environmental Protection Agency proposed a ban for most uses of lindane. Head lice shampoos would not be affected.
Antidote	No antidote available.
Acute Health Effects	As an organochlorine, lindane may disrupt the function of the nervous system, principally that of the brain. Acute symptoms may include headache, disorientation, apprehension, weakness, muscle twitching and convulsions. Chlorinated hydrocarbons are fat soluble and may be stored in human body fat. *Morgan, D.P., 1977. Recog. & Mgmt. of Pesticide Poisonings, U.S. EPA, Washington, D.C. A 2-year-old boy developed aplastic anemia after playing with a dog treated with lindane solution for mange. *Vodopick, H. "Cherchez la Chienne: Erythropoietic Hypoplasia After Exposure to γ-Benzene Hexachloride." JAMA, 234(8), 850-851, 1975. Lindane can be absorbed through the skin.
Indications of Possible Chronic Health Effects	Lindane has been shown to cause cancer in rats and mice. *Reuber, M.D., 1979. "Carcinogenicity of Lindane." Environ. Res. 19(2): 460-481. *Reuber, M.D., 1979. "Carcinomas and Other Lesions of the Liver in Mice Ingesting Organochlorine Pesticides." Toxicol. Annu. 3:231-256. Lindane has been found to be mutagenic in human cell cultures and plant root tips. *Vachkova-Petrova, R. (Inst. Hyg. & Occup. Dis., Med. Acad., Sofia, Bulgaria), 1978. Mutagenna aktivnost na pestitsidite. [Mutagenic activity of pesticides]. Khig. Zdraveopaz. 21(5):496-605. (Bulgarian). *Kølmark, F.G. "The Induction of Cytogenetic Changes and Atypical Growth by Hexachlorocyclohexane." Science, 109, 467-468. Long-term administration of lindane to rats resulted in decreased fertility and produced teratogenic, carcinogenic and central nervous system effect. *Petescu, S., V. Dobre, M. Leibovici, Z. Petrescu, S.A. Ghelberg, 1974. "The Effects of Long-Term Administration of Organochlorine Pesticides (lindane, DDT) on the White Rat." Rev. Med. Chir. 78(4):831-842.

The Center for the Integration of Applied Sciences, a division of the John Muir Institute (1010 Grayson Street, Berkeley, California 94710), focuses on urban integrated pest management. Materials on IPM concepts, procedures, resources and management techniques are available for the general public and professionals.

In 1980, in conjunction with a two-year Cooperative Agreement between the Institute and the EPA to provide technical assistance to public and private agencies seeking alternative pest management approaches, CIAS prepared several pesticide information sheets. They were designed to provide some basic information on common pesticides together with references from standard sources, including Pesticide Abstracts, Chemical Regulation Reporter, Environmental Protection Agency (EPA) documents, and literature searches conducted by the EPA. They do not represent original toxicological or epidemiological research by CIAS, and specialized expertise was not drawn upon in their preparation. Funds are not available to update or revise the sheets. Therefore, the sheets should only be used as a general guide to information that is available to the public and not considered in any way definitive.

ADDITIONAL INFORMATION

FOR FURTHER INFORMATION ON PESTICIDES

The following groups and individuals are working on the legal and medical aspects of pesticides. Some groups are also involved in finding alternatives. Many have regular publications and newsletters.

California Rural Legal Assistance 2111 Mission St. Suite 401 San Francisco, CA 94110	Emphasizes farm worker issues. (415) 864-3405
Citizens Against Toxic Sprays (CATH) 2737 25A Street Clarkston,WA 99403	Emphasizes herbicide use in forests. (509) 758-5796
Citizens for a Better Environment (CBE) 88 First Street San Francisco, CA 94105	Emphasizes California and citizen involvement (415) 777-1984
Coordinating Committee on Pesticides (CCOP) 88 First Street San Francisco, CA 94105	Emphasizes California legislation and regulation. (415) 543-3706
Environmental Action Foundation (EDF) 724 Dupont Circle Bldg. Washington, D.C 20036	Emphasizes federal legislation. (202) 296-7570
Environmental Policy Center 317 Penna Ave., S.E. Washington, D.C 20003	Emphasizes federal environmental policy and legislation.
Environmental Defense Fund (EDF) 2606 Dwight Way Berkeley, CA 94704	National legislative scope. (415) 548-8906
Friends of the Earth (FOE) 530 7th Street, S.E. Washington, D.C. 125 Spear Street San Francisco, CA 94105	National and international pesticide issues, including regulation of pesticide exports. (415) 433-7373
Hazard Evaluation System and Information Service (HESIS) 2151 Berkeley Way, Rm. 504 Berkeley, CA 94704	Emphasizes medical and epidemiological studies and tests. (415) 540-3015
National Coalition Against Misuse of Pesticides (NCAMP) 530 7th Street, S.E. Washington, D.C. 20003	Involved on national and local levels. (202) 543-4312
Natural Resources Defense Council (NRDC) 25 Kearney St. Suite 200 San Francisco, CA 94108	Emphasizes litigation and legislation at federal level. (415) 421-6561

Natural Resources Defense Council (NRDC) 1725 "I" Street, N.W. Washington, D.C. 20006	Emphasizes litigation and legislation at federal level. (202) 223-8210
122 E. 42nd St. New York, N.Y. 10168	(212) 949-0049
Northwest Coalition for Alternatives to Pesticides (NCAP) P.O. Box 375 Eugene, OR 97440	Emphasizes herbicides, forest use, agriculture, and alternatives. (503) 344-5044
Rachel Carson Council 8940 Jones Mill Road Chevy Chase, MD 20815	Follows federal legislation, publishes toxicity reports. (301) 652-1877
Save Our Ecosystems (SOS) 540 Kingswood Ave., Eugene, OR 97405	Activist orientation, with Northwest focus.
Ruth W. Shearer, PH.D. Consultant in Genetic Toxicology 2017 East Beaver Lake Drive Issaquah, WA 9802[illegible]	
Texas Pesticide Research and Education Project Box 1931 Austin, TX 78767	Focuses on agricultural and Southern states' pesticide use. (512) 474-0811
United States EPA - Special Pesticides Review Division	(202)557-7438

SUPPLEMENTARY READINGS

America The Poisoned: How deadly chemicals are destroying us, our wildlife, our environment and how we can survive.
Lewis Regenstein.
Acropolis, 1982.

Cockroach Clean-Up Tour.
Kathleen Letcher Cowles.
JMI, Inc., 1983.
Teaching packet includes take-home booklet, filmstrip, posters and lesson plans that insert pest management basics into the school curriculum, grade levels K-6. (Review copies now available.)

Controversial Chemicals: A Citizens Guide.
P. Kruus and I.M. Valeriote (editors).
Multiscience Publications, 1979.
Created to inform, not to inflame. Written for the general public, teachers and students.

Environmental Conservation.
Raymond F. Dasmann.
John Wiley & Sons, Inc., 1972.
This book looks at our environment and human problems from an ecological viewpoint.

Humanscape: Environments for People.
Stephen Kaplan and Rachel Kaplan (editors).
Wadsworth Publishing Company, Inc. 1978.
Discusses the uncertain environment in which humans live and views this uncertainty as a problem and as challenge.

The Integral Urban House: Self Reliant Living in the City.
Helga Olkowski, Bill Olkowski, Tom Javits and the Farallones Institute Staff.
Sierra Club Books, 1979.
Shows how to achieve a high quality urban way of life using a fraction of the resources we are accustomed to, at a lower cost, and with less waste, pollution and ugliness.

The IPM Practitioner Newsletter.
William Olkowski, Helga Olkowski, Sheila Daar (editors).
Bio Integral Resource Center.
A review of the latest IPM publications, research, techniques, and products. Covers both urban and agricultural ecosystem management.

The Least is Best Pesticide Strategy, A Guide to Putting Integrated Pest Management Into Action.
J. Goldstein and R.A. Goldstein.
The JG Press, 1978.
Written for consumers, farmers, students and policy makers to signal why IPM is beneficial. Reviews research and economic results. Discusses the organic movement.

Man's Habitat - The City: An Environmental Investigation Into the Urban Ecosystem.
Minnesota Environmental Sciences Foundation, Inc.
National Wildlife Federation, 1971.
Provides the city child with a chance to understand ecology without ignoring the apparent influence of man. The suggested activities involve the students with the study of their own immediate environment. Grade levels 4-9.

The Pesticide Conspiracy.
Robert van den Bosch.
Anchor Press, Doubleday, 1980.
A noted entomologist presents the politics behind the use and abuse of pesticides.

Silent Spring.
Rachel Carson.
Houghton Mifflin, 1962.
One of the first books to discuss environmental degradation caused by pesticides.

Since Silent Spring.
Frank Graham, Jr.
Houghton Mifflin, 1970.
Discusses the controversy raised by Carson's book and some avenues open to citizens concerned about pesticides.

Twelve Little Housemates.
Pergamon Press Inc., 1979.
Brief introduction to twelve common household arthropod. Good for the lay person.

The World of Insects.
Adriano Zanetti.
Abbevill Press, 1978.
Stunning introduction to entomology, illustrating the structure, life cycles and economic importance of insects.

Addresses of Minor Publishers:

Abbevill Press
505 Park Ave.
New York, NY 10022

Bio Integral Resource Center
Rte. 1, Box 28A
Winters, CA 95694

The JG Press
Box 351
Emmaus, PA 18049

JMI, Inc.
743 Wilson St.
Napa, CA 94558

Multiscience Publications
1253 McGill College, Suite 175
Montreal, Quebec, Canada H3B2Y5

Pergamon Press Inc.
Maxwell House, Fairview Park
Elmsford, NY 10523

Publications available from the John Muir Institute's
Urban Pest Management Program

General IPM Information $ 11.50

Packet of articles includes Summary of Pest Control Methods, Understanding Integrated Pest Management, Pest Control Strategies: Urban Integrated Pest Management, Ecosystem Management: A Framework for Urban Pest Control, Entomophobia in the Urban Ecosystem, Options in Pest Management, and others

Controlling Cockroaches, Rodents and Head Lice $ 11.50

Packet of articles includes a comicbook on cockroach control designed for apartment dwellers, reprints of articles appearing in the IPM Practitioner newsletter on roaches, rodents, and head lice, and a collection of articles on head lice management, with steps for non-toxic removal of lice

Controlling Other Common Pests $ 13.00

Packet of articles includes reprints on mosquitoes, urban flies, fleas, house plant pests, termites, garden pests, and shade tree pests.

Designing IPM Programs $ 7.50

Packet includes articles on urban ecosystem management, including Directions for Appropriate Habitat Redesigns, Model Ecosystem Management Programs, IPM for School Districts, Urban IPM Delivery Systems, and Making the Transition to an Urban IPM System.

To order, send the name of the packet(s) you want together with a check or money order (please include 15% for postage and handling), to:

JMI
743 Wilson Street
Napa, CA 94558

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